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ORIGINAL ARTICLE

Comparison of Immediate Implant Placement Following Extraction with and Without Socket-Shield Technique in Esthetic Region

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Abstract
Introduction Immediate implant with socket shield and immediate implant without socket shield are the two techniques which can be used to preserve the already thin labial bone in the esthetic region, thus eliminating the need for graft materials.
Aim To compare the efficacy of immediate implant placement after extraction without socket-shield technique and with socket-shield technique in the esthetic region.
Materials and Methods Sixteen patients who reported with unsalvageable maxillary anterior teeth with labial bone thickness of less than 2 mm, depicted on preoperative CBCT, were chosen for the study and randomly assigned one of the two groups: Group A comprising socket-shield technique patients and Group B comprising immediate implant placement without socket shield. The labial bone thickness was analyzed along its entire length through CBCT scan at definite follow-up intervals up to a period of 12 months after the procedure.
Results Follow-up of 1 year demonstrated a statistically significant reduction in the labial bone thickness at the crest in Group B after 8th and 12th months of implant placement.
Conclusion The two techniques need further comparison though our study results demonstrated better preservation of bone through the socket-shield technique, thus eliminating the need for any bony substitutes.

Keywords Socket-shield technique · Immediate implants · Labial bone thickness

Introduction

The rehabilitation of a tooth with hopeless prognosis in the esthetic zone without esthetic compromise with an implant remains elusive to date. Bone resorption of up to an average width of 50% or 3.8 m has been reported. Losses in height of 2–4 mm or 1.24 mm on average have also been measured [1]. However, this resorption process is highly variable and not fully predictable [2]. A substantial 0.5–1% of the alveolar ridge volume is lost as the result of it [3]. The loss of the "horizontal" dimension at the buccal aspect of the maxillary front tooth region following tooth loss amounted to between 3 and 3.5 mm [4].

Currently, the two techniques, immediate implant placement and the socket-shield technique are being widely used to preserve the labial bone. To streamline the process and reduce treatment time, immediate implant protocols have been introduced, which report a similar survival rate as delayed implants [5]. They can also provide a pleasing esthetic result with good function in selected situations [6, 7], but not on a predictable basis, and have a higher risk for mucosal recession and volume loss, whereas the rationale behind the intentional retention of the buccal aspect of the root with its periodontal apparatus is that a portion of the blood supply that is derived from the PDL is retained [8, 9]. Moreover, the flapless approach that is utilized allows for maintenance of the blood supply from the supraperiosteal vasculature running through the periosteum attached to the buccal plate of the ridge. This technique therefore facilitates the preservation of the dimensions and esthetics of the ridge based on biological principles rather

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than on any biomaterial. This technique came to be known as the socket-shield technique.

In the past, there has been only one study by Abadzhiev et al. [10] that compares the efficacy of the two techniques. Our study focuses on the efficacy of the two techniques in preserving the labial bone thickness on the labial aspect of the teeth in the maxillary anterior region.

Material and Method

Patients with unsalvageable maxillary anterior teeth, who reported to the Department of Oral and Maxillofacial Surgery of Saraswati Dental College, Lucknow, were randomly selected for the study. Age of patients ranged from 18 to 30 years. CBCT investigation was done to assess the thickness of the labial cortical plate. Patients who were found to have an intact labial cortical plate of less than 2 mm thickness in CBCT were included in our study. A total of sixteen patients were selected on this basis. These patients were randomly assigned to one of the two groups: Group A—socket-shield technique of immediate implant, Group B—immediate implant without socket shield, with eight patients in each group. The study was conducted after obtaining approval from the "Institutional Human Ethical Committee" and "Institutional Research and Development committee."

Inclusion Criteria

(1) Patients in the age-group of 18–50 years were selected.
(2) Patients who presented with extraction of anterior teeth when the buccal cortical plate was still intact and the thickness was found to be < 2 mm in CBCT.
(3) Patients with health status ASA I and ASA II.
(4) Patients who agreed to participate in the study.

Exclusion Criteria

(1) Medically compromised patients.
(2) Perforated labial cortical plate seen in CBCT.
(3) Pregnant females and lactating mothers.
(4) Patients undergoing radiation therapy or history of radiation within the last two years.
(5) Patients with a history of psychiatric illness or allergy to the drugs or anesthetics under evaluation.
(6) Patients who were not willing to participate in the study or come for follow-up.

Implant Procedure

In Group A, the gingival margin was carefully reflected and slight periosteal scoring was done to raise a small flap. Stripping of the periosteum was kept minimum so that the bundle bone was not devoid of its blood supply. The tooth was split horizontally supra-gingivally, and the crown fragment was carefully dislocated and removed using elevators and forceps. The tooth was sectioned vertically using no. 14 long tapered fissure diamond burs. Conservative extraction of the palatal side of root fragment was done with elevators and forceps. The labial fragment of the tooth was trimmed to sub-gingival level. Osteotomy site was prepared palatal to the retained facial root fragment using osteotomy drills at 800–1000 RPM and 40 Ncm. The suitable sized implant was then placed in this osteotomy site in contact with the labial root fragment. The labial and palatal gingival margins were then sutured using the small flap raised earlier to coronally reposition it on the facial side so that the labial sleeve of the tooth was completely covered and periodontal pack was placed at the site (Fig. 1a–g).

In Group B, crevicular incision was made around the adjacent teeth. Mucoperiosteal flap was raised, and implant was placed immediately after minimally traumatic extraction. Primary closure of the implant site was achieved.

Evaluation Criteria

In addition to the routine follow-up visits, the cases were called 1st, 4th, 8th and 12th months postoperatively. The crown was placed after the second surgery at 4th month. The labial cortical thickness was evaluated along its entire length at the following distances from the crest (Fig. 2):

(1) 0 mm at the crest.
(2) 3 mm apical to the crest.
(3) 6 mm apical to the crest.
(4) 9 mm apical to the crest.

Evaluation of labial cortical thickness at the above-mentioned levels was done using I-CAT CB 500 (Gendex) cone beam 3D imaging system with high resolution (125 μm voxel), standard exposure time (14 s), tube voltage 90KVp and 5 Ma. Data were acquired as a volume acquisition and reconstructed in multiple planes. To study the labial cortical thickness in cross sections, 1-mm sections were used, showing the maxillary anterior region in reconstructed quadrant anterior maxillary scan. The thickness of the labial cortical plate was measured using the distance measurement tool in labio-palatal direction. CBCT has 80–100% sensitivity in examination and determination of the alveolar bone loss, while conventional radiographic methods show about 63–67% sensitivity [11].

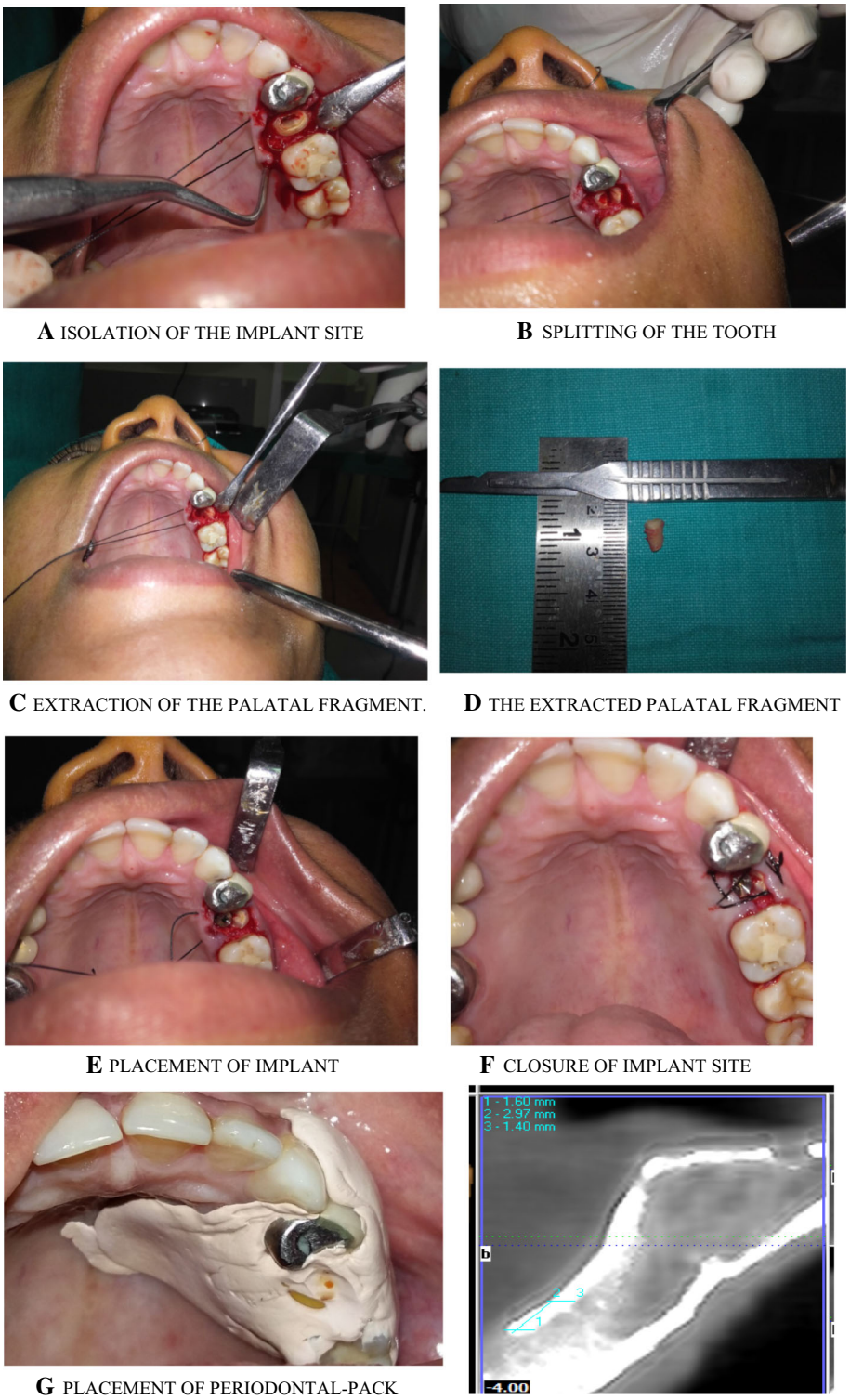


Fig. 1 Demonstration of socket-shield procedure

A ISOLATION OF THE IMPLANT SITE

B SPLITTING OF THE TOOTH

C EXTRACTION OF THE PALATAL FRAGMENT.

D THE EXTRACTED PALATAL FRAGMENT

E PLACEMENT OF IMPLANT

F CLOSURE OF IMPLANT SITE

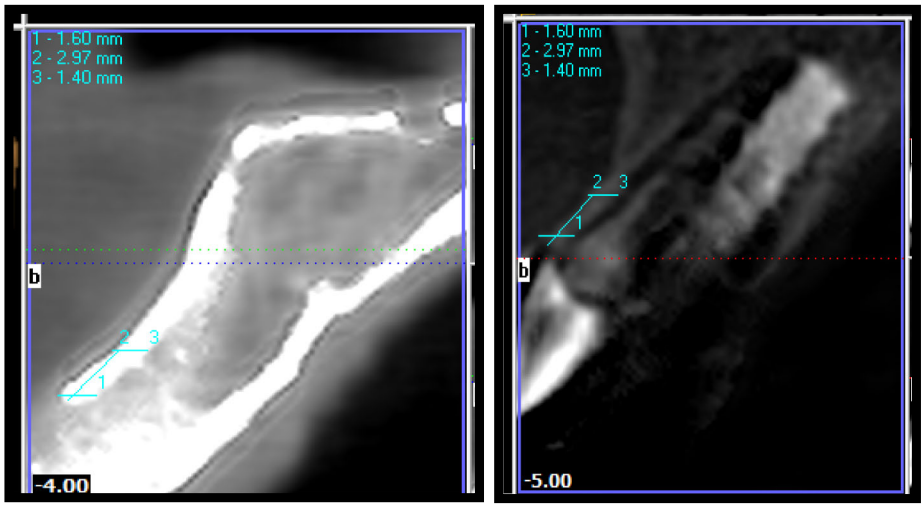
G PLACEMENT OF PERIODONTAL-PACK

Alqerban et al. [12] added that CBCT (3D) is more sensitive than the conventional X-ray (2D) both for locating dental structures and for identifying sites of initial resorption.

Statistics and Results

The difference in the thickness of the labial bone was not found to be statistically significant at the crest between the two groups at any follow-up (Table 1, Fig. 3).

Preop 11,21 12 Months post-op



Preop measurements 11 12 months post op

Fig. 2 Method demonstrating the measurement of labial cortical thickness in labio-palatal direction in cross section of reconstructed maxillary anterior quadrant scan

Table 1 Comparison of thickness of labial bone at 0 mm position between the two implant techniques at various follow-ups

At 0 mm position	Group A		Group B		*t* value	*p* value
	Mean	SD	Mean	SD		
Pre-op.	1.175	0.249	1.175	0.198	0.000	1.000
1st Month post-op.	1.173	0.247	1.150	0.200	0.200	0.844
4th Month post-op.	1.170	0.247	1.144	0.192	0.238	0.816
8th Month post-op.	1.145	0.277	1.019	0.141	1.148	0.270
12th Month post-op.	1.145	0.277	0.988	0.173	1.364	0.194

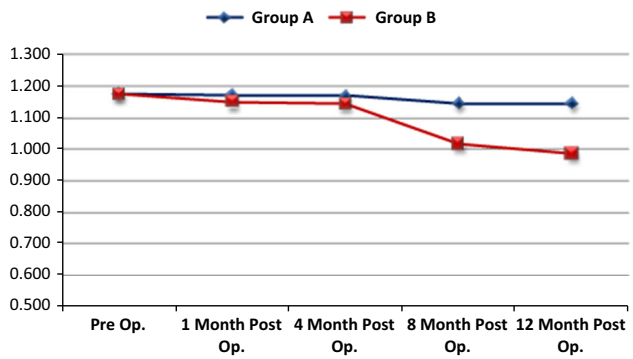


Fig. 3 Comparison of thickness of labial bone at crestal position (0 mm) between the two implant techniques at various follow-ups

In Group A, the differences in mean bone loss among various follow-ups at the crest were not found to be statistically significant ($p = 0.330$). However, in Group B the differences in mean bone loss among various follow-ups were found to be statistically significant at 8th and 12th months only ($p < 0.001$) (Table 2, Fig. 4).

Though the results were found to be statistically insignificant, there was more bone loss in Group B as evident from the mean values of both the groups and graphs comparing the bone loss in both groups (Tables 3, 4, 5, 6, 7 and 8; Figs. 5, 6, 7, 8, 9 and 10).

Table 2 Within-group comparison of bone loss of labial bone from baseline (pre-op.) at 0 mm position at various follow-ups for the two groups

Follow-up	Group A			Group B		
	From pre-op.			From pre-op.		
	Mean	SD	Bonferroni *p* value	Mean	SD	Bonferroni *p* value
1st Month post-op.	0.002	0.002	1.000	0.025	0.016	1.000
4th Month post-op.	0.005	0.003	1.000	0.031	0.016	0.950
8th Month post-op.	0.030	0.025	1.000	0.156	0.029	**0.010**
12th Month post-op.	0.030	0.025	1.000	0.188	0.013	**< 0.001**
F value	1.206			31.043		
p value	0.330					

Bold values denotes that changes in bone loss from preop is significant in group B as it has a *p* value which is less than 0.001

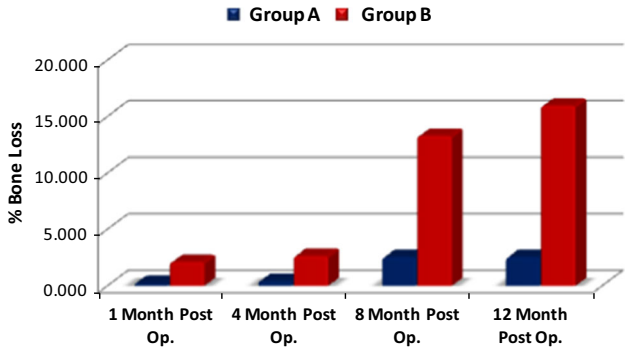


Fig. 4 Within-group comparison of change in thickness of labial bone from baseline (pre-op.) at 0 mm position at various follow-ups for the two groups

Discussion

Evaluation of Bone Resorption at Crestal Level (0 mm)

Maxillary anterior dentition is the region where the labial bone has been found to be thin in various studies (< 2 mm). The thickness of the labial bone at the crest found in this study agrees with that by Shen et al. [13] who measured the thickness of the facial wall of anterior maxillary teeth and premolars based on CBCT images. Shen found that the thickness of the facial alveolar bone of maxillary anterior teeth ranged from 0.5 to 1.5 mm and concluded that it is common for teeth in the anterior maxilla to have thin facial bone walls. Bjarni et al. [14] in their study mentioned that in the anterior sites, a vast majority of the buccal bony walls (87.2%) had a

Table 3 Comparison of thickness of labial bone at 3 mm position between the two implant techniques at various follow-ups

At 3 mm position	Group A		Group B		*t* value	*p* value
	Mean	SD	Mean	SD		
Pre-op.	1.300	0.185	1.325	0.149	− 0.298	0.770
1st Month post-op.	1.298	0.184	1.288	0.125	0.127	0.900
4th Month post-op.	1.298	0.184	1.270	0.157	0.321	0.753
8th Month post-op.	1.298	0.184	1.228	0.168	0.795	0.440
12th Month post-op.	1.298	0.184	1.224	0.165	0.845	0.412

Table 4 Within-group comparison of bone loss of labial bone from baseline (pre-op.) at 3 mm position at various follow-ups for the two groups

Follow-up	Group A			Group B		
	From pre-op.			From pre-op.		
	Mean	SD	Bonferroni *p* value	Mean	SD	Bonferroni *p* value
1st Month post-op.	0.002	0.002	1.000	0.038	0.026	1.000
4th Month post-op.	0.002	0.002	1.000	0.055	0.026	0.685
8th Month post-op.	0.002	0.003	1.000	0.098	0.032	0.180
12th Month post-op.	0.002	0.003	1.000	0.101	0.031	0.130
F value	0.304			3.777		
p value	0.873			0.014		

Table 5 Comparison of thickness of labial bone at 6 mm position between the two implant techniques at various follow-ups

At 6 mm position	Group A		Group B		*t* value!	*p* value
	Mean	SD	Mean	SD		
Pre-op.	1.575	0.292	1.525	0.238	0.376	0.713
1st Month post-op.	1.563	0.292	1.513	0.210	0.393	0.700
4th Month post-op.	1.545	0.301	1.500	0.262	0.319	0.754
8th Month post-op.	1.573	0.293	1.410	0.244	1.204	0.249
12th Month post-op.	1.568	0.299	1.435	0.229	0.995	0.337

Table 6 Within-group comparison of bone loss of labial bone from baseline (pre-op.) at 6 mm position at various follow-ups for the two groups

Follow-Up	Group A			Group B		
	From pre-op.			From pre-op.		
	Mean	SD	Bonferroni *p* value	Mean	SD	Bonferroni *p* value
1st Month post-op.	0.013	0.013	1.000	0.013	0.013	1.000
4th Month post-op.	0.030	0.027	1.000	0.025	0.025	1.000
8th Month post-op.	0.002	0.002	1.000	0.115	0.034	0.117
12th Month post-op.	0.008	0.004	0.796	0.090	0.034	0.339
F value	0.921			5.094		
p value	0.466			0.003		

Table 7 Comparison of thickness of labial bone at 9 mm position between the two implant techniques at various follow-ups

At 9 mm position	Group A		Group B		*t* value!	*p* value
	Mean	SD	Mean	SD		
Pre-op.	1.700	0.441	1.725	0.260	− 0.138	0.892
1st Month post-op.	1.638	0.385	1.725	0.260	− 0.532	0.603
4th Month post-op.	1.644	0.382	1.723	0.262	− 0.481	0.638
8th Month post-op.	1.645	0.386	1.610	0.295	0.204	0.841
12th Month post-op.	1.643	0.387	1.613	0.275	0.179	0.861

Table 8 Within-group comparison of bone loss of labial bone from baseline (pre-op.) at 9 mm position at various follow-ups for the two groups

Follow-up	Group A			Group B		
	From pre-op.			From pre-op.		
	Mean	SD	Bonferroni *p* value	Mean	SD	Bonferroni *p* value
1st Month post-op.	0.063	0.073	1.000	0.000	0.000	–
4th Month post-op.	0.056	0.035	1.000	0.002	0.002	1.000
8th Month post-op.	0.055	0.032	1.000	0.115	0.034	0.117
12th Month post-op.	0.058	0.031	1.000	0.113	0.035	0.148
F value	0.885			8.536		
p value	0.485			< 0.001		

thickness < 1 mm, and only 2.6% of the walls were 2 mm thick. Their study reported a mean thickness of 0.80 mm in the maxillary anterior region from canine to canine. In the premolars, the thickness was found to be 1.1 mm. The mean crestal bone thickness in anterior maxilla was found to be 0.82 mm in a study by Gupta et al. [15]. Cho et al. [16] found a thickness of 1.91 ± 0.45 mm before implant placement. Spray et al. [17] observed the change in the labial bone thickness after the second surgery. According to their findings, average thickness of the labial bone was 1.7 mm at implant placement. During the second surgery, the mean bone resorption was 0.7 mm. In a study by Abadzhiev et al. [10], socket-shield patients showed a mean loss of 0.8 mm in 2 years, while the immediate implant group showed a mean loss of 5 mm in 2 years. Baumer et al. [18] in their study found a mean loss of

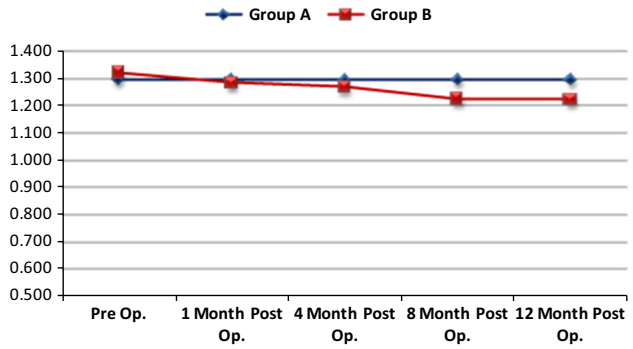


Fig. 5 Comparison of thickness of labial bone at 3 mm position between the two implant techniques at various follow-ups

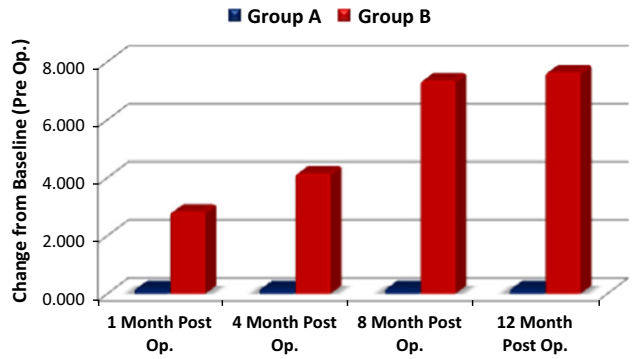


Fig. 6 Within-group comparison of bone loss of labial bone from baseline (pre-op.) at 3 mm position at various follow-ups for the two groups

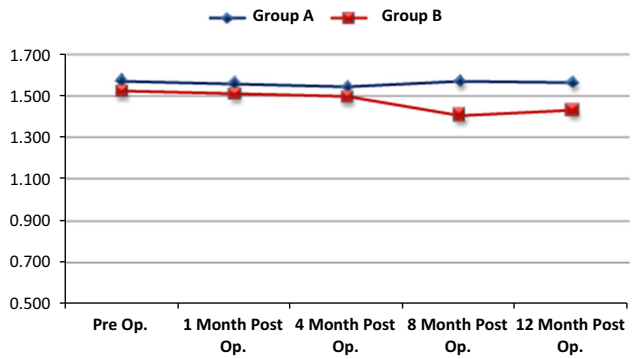


Fig. 7 Comparison of thickness of labial bone at 6 mm position between the two implant techniques at various follow-ups

0.88 mm in labial direction, and histologic assessment in their study revealed no osteoclastic changes at the crest.

In a CBCT study, on comparison of immediate implant placement with delayed, mean labial bone thickness was calculated at the crest after a mean time period of 47 ± 12.01 months after setting the abutment [19]. They found the thickness to be 0.48 ± 0.67 mm. Postoperative measurement in a study done after atraumatic internal fragmentation of root on 15 patients by Wilfried Engelke

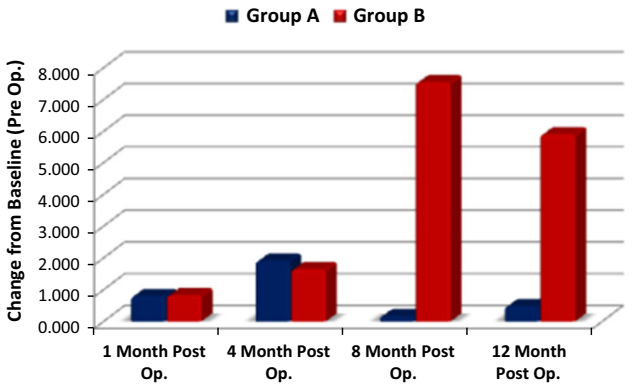


Fig. 8 Within-group comparison of bone loss of labial bone from baseline (pre-op.) at 6 mm position at various follow-ups for the two groups

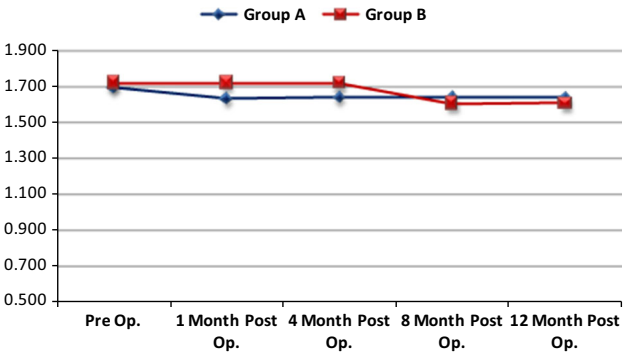


Fig. 9 Comparison of thickness of labial bone at 9 mm position between the two implant techniques at various follow-ups

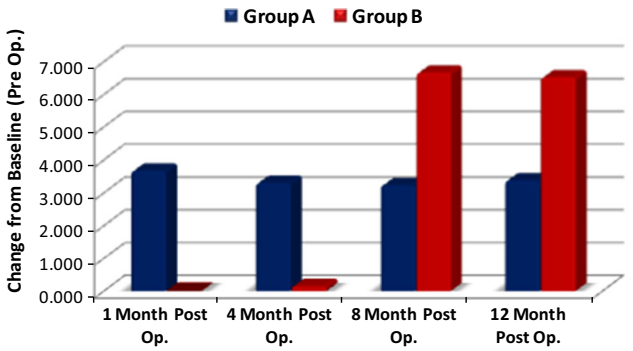


Fig. 10 Within-group comparison of bone loss of labial bone from baseline (pre-op.) at 9 mm position at various follow-ups for the two groups

et al. [20] revealed mean crestal thickness of 1.11 mm preoperatively and mean labial bone thickness of 1.40 mm immediate postoperatively.

At 3 mm Apical to the Crest

The mean bone loss at this level was studied by Januário et al. [21] who measured the labial bone in maxillary

anterior dentition at 1 mm, 3 mm and 5 mm apical to the crest. In their study, they found that the facial bone wall in most locations in all tooth sites examined was $\leq$ 1 mm thick and that close to 50% of sites had a bone wall that was $\leq$ 0.5 mm thick. The values were in the range of 0.6 ± 0.4 to 0.7 ± 0.4 at 3 mm apical to the crest. A CBCT study on alveolar bone anatomy at the maxillary anterior region in 80 Chinese adults found that the diameter at 3 mm from the crest was rather thin [22]. They concluded that the labial bone thickness at this level is $<$ 1 mm. Alsaffar et al. [23] in their study found that in the middle of the root the values were in the range of 0.9 ± 0.86 and 1.4 ± 1.23 mm for different age-groups.

In the study on immediate implant placement, the mean labial bone thickness at the middle section was found to be 1.19 ± 0.60 after 47 ± 12.01 months of abutment setting [19]. The mean labial bone thickness in our study at different intervals was found to be 1.288, 1.270, 1, 228 and 1.224 mm at 1st, 4th, 8th and 12th months of follow-up. In a case report by Gluckman et al. [24], follow-ups at different time intervals were done during which healing was reported to be good.

At 6 mm Apical to the Crest

The mean bone loss at this level was studied by Januário et al. [21] who measured the labial bone in maxillary anterior dentition at 1 mm, 3 mm and 5 mm apical to the crest. At 5 mm, they found a mean in the range of 0.5 ± 0.3 mm to 0.6 ± 0.4 mm.

At 9 mm Apical to the Crest

At this level, there was a slightly higher loss in Group B though not statistically significant. In the study by Alsaffar et al. [23], the mean labial bone thickness was found to be in the range of 1.7 ± 1.41 to 2.27 ± 7.36 in the apical region. In the study by Engelke et al., on atraumatic internal fragmentation of root more loss in the labial bone thickness was observed at the apical level amounting to a mean of 0.26 mm.

Conclusion

Our study documents the loss of the labial bone thickness at different levels from the crest at various intervals of follow-up, leading to the conclusion that socket-shield technique better preserves the labial bone thickness, but the present study had a small sample size. Further studies on larger samples need to be carried out in order to study the usefulness of both the techniques in the maxillary anterior region. In a study [25], CBCTs also showed the retained piece of the root buccal of the implant. Only in one case, apical resorption of the shield was reported.

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Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

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