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SOCKET SHIELD AND BIOACTIVE GLASS AROUND ANTERIOR MAXILLA IMMEDIATE DENTAL IMPLANTS

Maher Abdullatif Walid* *and* Mohamed Ahmed Alkhodary**

ABSTRACT

Introduction: This study aimed at testing the effect of the socket shield technique on the maintenance of the labial plate of bone and the change in position of its surrounding gingival soft tissues upon the immediate placement of 3 different dental implants systems, with a bone graft material filling the defects around the implants, followed by clinical and radiographic evaluation using the cone beam computed tomography after 4 and 12 months of loading.

Materials and Methods: Three groups, 6 male patients each, having a failing central or lateral maxillary incisor, had their failing tooth partially extracted, with the remaining tooth half reduced to be the socket shield, then the 3 groups received 3 different dental implants systems, the Tapered Internal implant RBT Laser-Lock for group I, the Touareg-S implant for group II, and group III received the Nobel Active implant. Then, the Novabone putty bone graft was dispensed in the space between the implant and the shield and covered with a customized healing abutment. After 4 months of healing, the patients were provided with definitive restorations, and followed after 4 and 12 months for gingival recession, papillae filling the interdental spaces, and CBCT evaluation of the labial plate of bone width and vertical resorption. Each result was then statistically analyzed.

Results: For all the cases in the study, no implant failed, no gingival recession was recorded, and the interdental papillae filled their spaces in most of the cases. also, no significant changes were recorded for the labial plate of bone width or height.

Conclusions: The socket shield technique was able to maintain the labial plate of bone and the position of the overlying free gingival margin, with the neighboring interdental papillae showing least dimensional changes.

KEY WORDS: Socket shield, immediate implants, bioactive glass, CBCT.

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INTRODUCTION

Partial tooth extraction, the root membrane, or the socket-shield technique is recently suggested to minimize the dimensional changes of the facial plate of the maxillary and mandibular alveolar bone with immediate implants after teeth extraction. However, some histologic evidence documented loss of bone, formation of cementum and fibrous tissue between the implant surfaces and the shield. [1-5]

Other studies were in favor of the socket shield, documenting successful distance and contact osteogenesis, despite an almost half centimeter space from the implant to the socket shield with no bone grafting or membrane assistance, and maintenance of the labial plate of bone as if no tooth extraction took place. [6-8]

Although, there are no determining guidelines in regards to the type of biomaterials, or surgical techniques used, an atraumatic extraction technique and a suitable bone graft material, can efficiently reduce vertical and horizontal bone resorption after teeth extraction. [9-14]

The osteostimulative properties of bone graft materials can lead to new bone formation within 4-6 months of healing and tend to increase over time which is ideal to ensure good quality of bone and sufficient thickness of the overlying soft tissue for long-term implant survival. [15-25]

Compared to delayed implants, immediate implants in the anterior maxilla encounter some adverse esthetic outcomes resulting from labial plate resorption and gingival recession. [26-28] However, improved implant macro-mechanical design, and surface treatments that can ensure long term biointegration, were found to minimize such complications in carefully selected patients. [29-38] In addition, flapless placement of immediate implants was found to provide numerous benefits, such as decreased trauma, short recovery time, less pain, reduced rate of infection and bone resorption, and eventually improved patient compliance. [41-47]

Immediate implants provisionalization is non-inferior to delayed provisionalization, however, it is technique-sensitive in the esthetic region of the mouth. [48-57] Another approach than immediate provisionalization is to use customized healing abutments which supports the free gingival margin, maintains or regenerates the interproximal papillae, and facilitates the production of physiologic proximal contacts and emergence profiles of the definitive restorations, which in turn lead to long term maintenance of such soft tissues architectures. [32, 58-62]

The dental implants clinical post-operative follow-up using periapical radiography was found to provide a better diagnostic accuracy that is higher and more valid than the cone beam computed tomography (CBCT) at detecting peri-implant bone defects. [63] However, periapical radiography provides a two dimensional visualization and is not able to show mid-buccal and mid-lingual bone defects around the dental implants, whereas in the CBCT cross sectional images, the distance measurement tool can measure the vertical bone resorption and the thickness of the labia bone plate with great accuracy when specific voxel size and mille-amperage were used. Additionally, radiographic analysis using CBCT before extraction was strongly advised to choose the appropriate dental implant dimensions and treatment approach. [64-78]

Since there is no guarantee that immediate implants and/or bone grafting can avoid the consequences of exodontia, this study aimed to test the effect of socket shield technique on maintaining the labial plate of bone and surrounding gingival tissues using clinical and CBCT evaluation.

MATERIALS AND METHODS

Eighteen male patients were selected from the out-patient clinics at the College of Dentistry, Qassim University-KSA. The procedures were explained to the patients before having their informed consent signed. The approval of the ethical committee of the college was obtained with a condition that a negative

control group was not to be included to guarantee that every patient is gaining the maximum benefit of the treatment modality under study.

Patients inclusion criteria were as follows: (1) age from 25 to 45 years old; (2) good oral hygiene; (3) having a single failing tooth in the anterior maxilla, namely the central or the lateral incisors with sound neighboring teeth; (4) the failing tooth and its neighbors must have defect free mucosa; (5) thick gingival biotype; (6) good alveolar bone all around the failing tooth.

Patients exclusion criteria were as follows: (1) bruxism; (2) systemic diseases affecting bone (3) smoking; (4) periodontal disease; (5) presence of a chronic abscess, or an abscess with a fistulous tract; (6) physiologically thin labia bone plate.

Random allocation of the patients to 3 groups of 6 patients each was done blindly, the groups then had similar procedures of base line CBCT for pre-operative planning of implant placement (fig. 1-3), partial tooth extraction and preparation of the socket shield, dental implant placement, bone graft injection around the implant, making of a custom made healing abutment, definitive prosthetic restoration, 4 months healing, clinical and CBCT follow up after 4 and 12 months of loading.

The condemned tooth, in figure 4a, was locally anesthetized, then root sectioning, as seen in figure 4b, in two segments with a long shaft bur (Komet Dental, Germany) mounted on a high-speed hand-piece with water cooling was done. Using a #1 periotome (Nordent, USA) the periodontal ligament of the palatal segment was severed carefully, and then palatal segment was extracted with meticulous care to maintain the labial root segment attached to labial bone plate as seen in figure 4c. The labial segment is turned into the socket shield, as seen in figure 4d, by vertical reduction to one millimeter occlusal to the labial bone plat ledge, and by thinning of its length and width using a large rose head diamond bur (Komet Dental, Germany) attached to a high-speed hand-piece with water cooling, this was followed

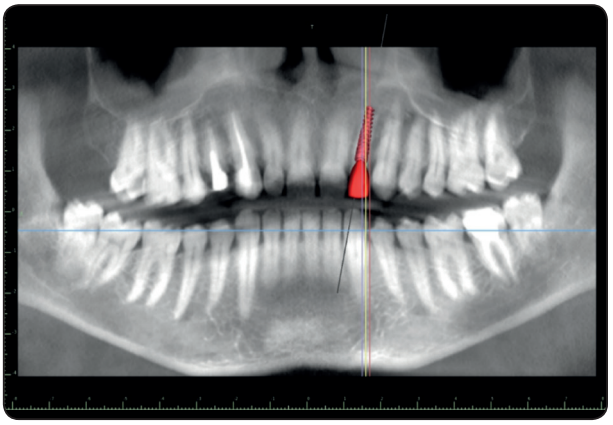

Fig. (1) : preoperative panoramic X-ray reconstructed from the CBCT and used for implant placement planning.

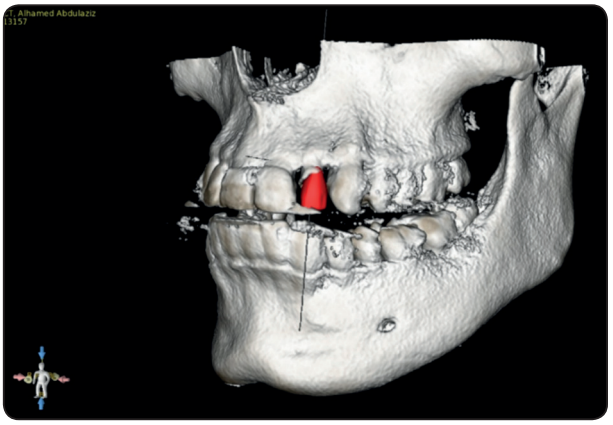

Fig. (2) CBCT 3 dimensional reconstruction of the patient skull with the proposed restoration in red.

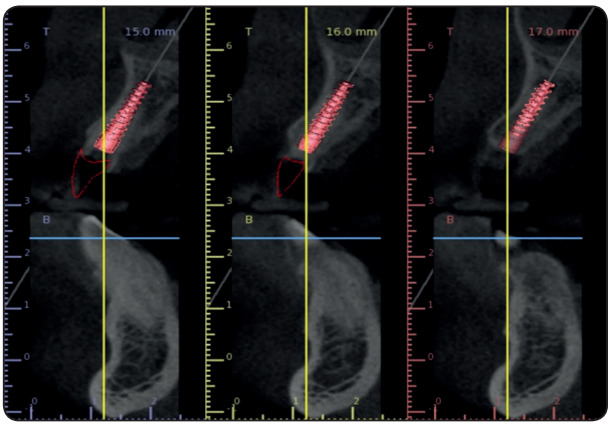

Fig. (3) CBCT cross sectional images showing the potential implant and crown position

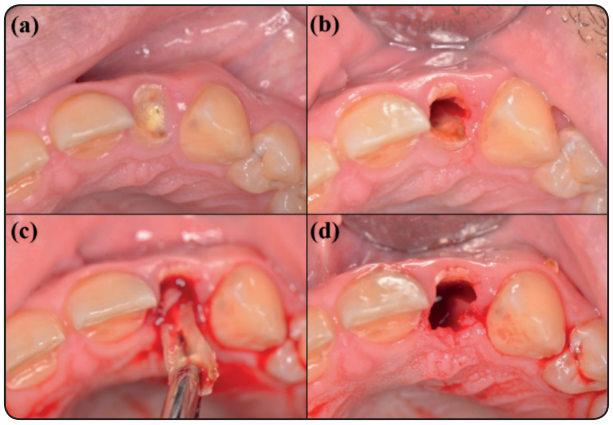

Fig. (4) Tooth extraction and preparation of the socket shield: (a) pre-operative clinical photograph of the failing tooth, (b) sectioning of the failing tooth into labial and palatal segments, (c) extraction of the palatal segment, (d) the labial segment prepared to be the socket shield.

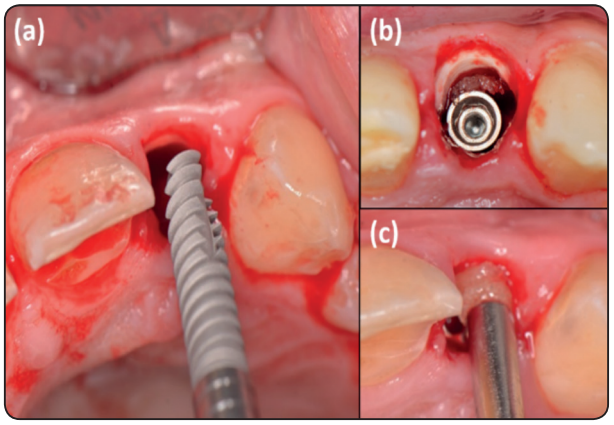

Fig. (5) Implant and bone graft placement: (a) immediate implant placement, (b) initial injection of the bone graft, (c) bone graft filling the space between the implant and the socket shield.

by curettage, saline irrigation, and inspection of the socket shield for mobility.

The implant osteotomy was then prepared sequentially with more palatal bias in the socket, and apical drilling to the fundus of the socket so that after implant placement its platform was apical to the free gingival margin by 4 mm as seen in figure 5 a, and b. Group I received the Tapered Internal implant RBT Laser-Lock (Biohorizon, USA) of 3.8 mm diameter and 15 mm length, group II received the Touareg-S implant (Adin, Belgium) of 3.5 mm and 16 mm length, and group III received the NobelActive implant (Nobel biocare, Sweden) of 3.5 mm diameter and 13 mm length. The diameters of the 3 implant systems were close to each other, however, the different lengths used were to make sure that there are 4 mm of the implant apical to the fundus of the extraction socket to ensure primary stability. Then. the Novabone ® (NOVEBONE PUTTY, USA) putty was dispensed in the defect between the implant and the shield as seen in figure 5b and c.

Following the bone graft injection, customized healing abutments were fabricated chair-side using titanium or plastic temporary abutment, that were attached to the implants, and around which light cured flowable composite (Filtek™ Bulk Fill Flowable Restorative, 3m, USA) was used to copy as much as possible the emergence profile of the extracted teeth in order to support the surrounding soft tissues. The constructed abutments were finished to S-shape emerging profile, as seen in figure 6a and b, to ensure adequate space with the buccal shield. Then the customized healing abutments were screwed in place as seen in figure 6c, and their contours were verified using periapical x-rays as seen in figure 7a-c, then, the patients were given the homecare instructions and mouth rinses in addition to the routine oral hygiene measures.

After 4-month the customized healing abutments were removed for final impression making as seen in figure 8a. Using rubber base materials (Express TM VPS impression material, putty and light body (3M, USA), a one step, open top tray, an implant level impression was made using an impression coping surrounded by light cured composite duplicating the emergence profile as seen in figure 8b, after making the impression, an implant analogue was secured to the impression coping as seen in figure 9a, and the impression was poured into hard stone. The patients were provided with temporary crowns that had their emergence profile perfected. Finally, after selection of the most suitable shade, each patient was provided with the definitive porcelain-

fused-to-metal crown that duplicated the temporary crown emergence profile using a light body index as seen in figure 9b and c. In order to change this crown into a screw retained rather than cemented prosthesis, it was first permanently cemented to the definitive custom abutment extra-orally, as seen in figures 10a, and b, using a resin cement (RelyX Unicem Self-Adhesive, 3M, USA), this helped to prevent excess cement escape into implant sulcular area. This crown was torqued in place, using 35 N\CM, as seen in figure 10c.

In the clinical and radiographic follow-up, the following parameters were assessed at the time of definitive crown insertion, and after 4 and 12 months of loading as follows:

(A) The implant osseointegration success or failure.

(B) Papillae filling of the interdental space using the Jemt papilla score [80] which assessed the shape of the papilla as follows: (0) no papilla is present; (1) less than half of the interdental space is filled with the papilla; (2) half or more of the interdental space is filled with the papilla; (3) the interdental space is filled with the papilla; (4) the papilla is hyperplastic.

(C) Gingival recession was evaluated using a graduated plastic tape to measure the distance from the incisal edge of the definitive crown to the zenith of the gingival margin.

(D) CBCT evaluation using the dental CBCT scanner (GALILEOS Comfort Plus, Sirona, Germany) which was operated at 98 kV, 3-6 mA, a focal spot size of 0.5 mm, with centered focal planes to the implant, and reconstructed the cross sectional images with the software (ware SIDEXIS XG (Sirona, Germany.

(a Thickness of the labial plate of bone was measured with the distance measuring tool of the software, at 1 mm from the implant shoulder to provide the cervical width and 5 mm from the implant platform to provide the middle section width as seen in figure 11.

(b Vertical resorption of the labial plate of bone was measured from a horizontal line, extending from the implant platform and perpendicular to the implant surface, to the alveolar ledge as seen in figure 11.

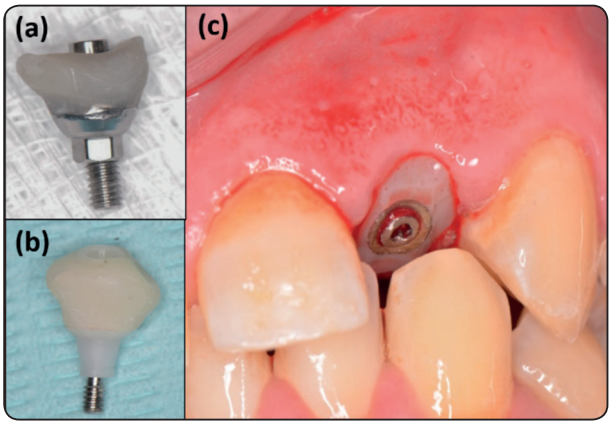

Fig. (6) The screw retained customized healing abutment: (a) the customized healing abutment prepared using a temporary titanium abutment and a light cured flowable composite resin, (b) the customized healing abutment made using a plastic temporary abutment, (c) the contoured customized healing abutment screwed in place to support the periimplant soft tissues during healing.

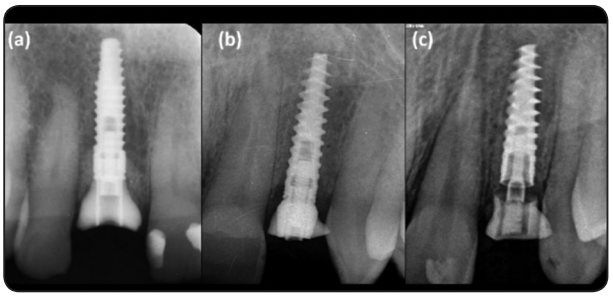

Fig. (7) Peri-apical x-rays immediately following screwing the customized healing abutment, (a) the Tapered Internal implant RBT Laser-Lock implant, (b) the Touareg-S Adin implant, and (c) the NobelActive implant, note the space between this implant and the customized healing abutment due to the use of a plastic temporary abutment.

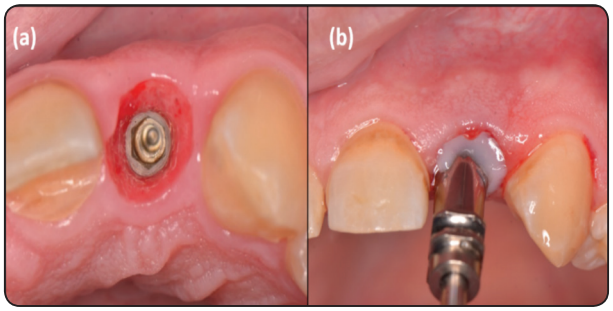

Fig. (8) removal of the customized healing abutment for final impression, (a) note the fresh bleeding mucosal surface which indicated the attachment of the soft tissues to the healing abutment, (b) attachment of an open top tray impression coping to the implant and filing the emergence profile space with flowable light cured composite to duplicate its contours.

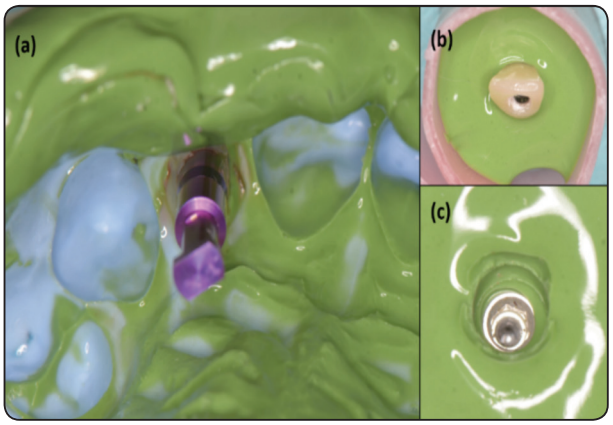

Fig. (9) Final impression and creation of the emergence profile, (a) the implant analogue attached to the impression coping in the final impression, (b) the screw retained temporary crown attached to an implant analogue and invested in in a cylinder made of light body impression material to duplicate the carefully reproduced emergence profile, (c) the temporary crown removed and the light body index is used to create the same emergence profile in the definitive crown.

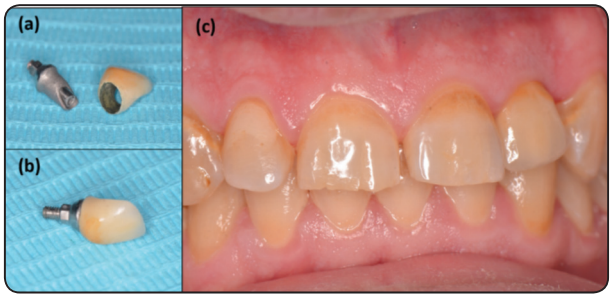

Fig. (10) The definitive restoration: (a) the definitive crown is made with a hole I its palatal surface to be screwed rather cemented to the implant, (b) the definitive crown cemented to the permanent abutment and excess cement removed, (c) the definitive crown and abutment screwed to the implant in the patient mouth, in this clinical photograph the implant restored the tooth number 22.

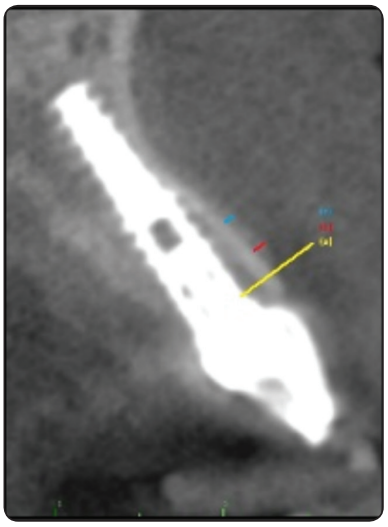

Fig. (11) CBCT follow up of the labial plate of bone: the vertical resorption of the labial plate of bone was measured from the yellow line perpendicular to the implant surface, emerging at the implant abutment connection. The red line represents the cervical width of the labial plate of bone measured 1mm from the implant platform. The blue line represents the mid-section width of the labial plate of bone measured 5 mm from the implant platform.

Finally, the Statistical analysis tests used in this study were the T Test for 2 dependent means to analyze the results of the change in papilla score, the Kruskal-Wallis test to analyze the differences in gingival recession, and values of the CBCT labial plate thickness and corresponding vertical resorption were analyzed using the Mann-Whitney U-test.

RESULTS

The current work evaluated the socket shield technique effect on the labial plate of bone, and its surrounding soft tissues, upon the restoration of a maxillary central or a lateral incisor tooth using an immediate dental implant and a bone graft. The participants of this study were carefully chosen, and

were given strict instructions about maintenance of good oral hygiene. Meticulous surgical and prosthetic techniques were followed to ensure best clinical outcomes. Table 1 shows the distribution of the follow up parameters values recorded during this one-year clinical trial, and table 2 shows the results of the statistical analysis of the results.

The implant stability: All the implants of the 3 groups were clinically stable, and none of them required removal.

The interdental papilla: A single score was used to describe the papillae on the mesial and distal of each implant, with the lower score being used, for example if the mesial papilla score is 3 and the distal papilla score is 2, then a score of 2 was used to describe the papilla score for this implant. All 3 groups showed a similar distribution and no significant differences in the papilla scores, where the papillae filled their spaces around the 3 implant systems used.

Gingival recession: No significant gingival recession was recorded from definitive crown insertion to the 4 months and 1-year follow-up in the 3 treatment groups.

Radiographic evaluation: The CBCT readings in this study were recorded twice by two different dental

TABLE (1) Distribution of follow up parameters values

Group	Implant number	Papillae score		Gingival recession		The labial plate of bone								
						At definitive crown insertion			4 months after definitive crown insertion			12 months after definitive crown insertion		
		After 4 months	After 12 months	After 4 months	After 12 months	Cervical width	Mid-section width	Vertical bone loss	Cervical width	Mid-section width	Vertical bone loss	Cervical width	Mid-section width	Vertical bone loss
Group I	1	3	3	0.00	0.00	1.7	2	0.00	1.7	2	0.00	1.7	2	0.00
	2	3	2	0.00	0.00	0.9	1.6	0.00	0.9	1.6	0.00	0.9	1.6	0.00
	3	3	3	0.00	0.00	0.7	1.2	0.00	0.7	1.2	0.00	0.7	1.2	0.00
	4	3	2	0.00	0.00	1.2	1.8	0.00	1.2	1.8	0.00	1.2	1.8	0.00
	5	3	2	0.00	0.00	1.7	2.8	0.00	1.7	2.8	0.00	1.7	2.8	0.00
	6	3	3	0.00	0.00	1	2.4	0.00	1	2.4	0.00	1	2.4	0.00
Group II	1	3	2	0.00	0.00	1.2	2.1	0.00	1.2	2.1	0.00	1.2	2.1	0.00
	2	3	3	0.00	0.00	1.3	1.7	0.00	1.3	1.7	0.00	1.3	1.7	0.00
	3	3	3	0.00	0.00	2.3	3.4	0.00	2.3	3.4	0.00	2.3	3.4	0.00
	4	3	2	0.00	0.00	2.2	3.2	0.00	2.2	3.2	0.00	2.2	3.2	0.00
	5	3	3	0.00	0.00	2.2	3.1	0.00	2.2	3.1	0.00	2.2	3.1	0.00
	6	3	3	0.00	0.00	2.3	3.4	0.00	2.3	3.4	0.00	2.3	3.4	0.00
Group III	1	3	3	0.00	0.00	1.2	2.4	0.00	1.2	2.4	0.00	1.2	2.4	0.00
	2	3	2	0.00	0.00	2.9	3.7	0.00	2.9	3.7	0.00	2.9	3.7	0.00
	3	3	3	0.00	0.00	2.1	2.8	0.00	2.1	2.8	0.00	2.1	2.8	0.00
	4	3	2	0.00	0.00	1.9	2.7	0.00	1.9	2.7	0.00	1.9	2.7	0.00
	5	3	3	0.00	0.00	1.4	2.6	0.00	1.4	2.6	0.00	1.4	2.6	0.00
	6	3	3	0.00	0.00	2	2.9	0.00	2	2.9	0.00	2	2.9	0.00

TABLE (2) Statistical analysis results

Follow up parameter	Statistical analysis test used		Group I comparison between 4 and 12 months	Group II comparison between 4 and 12 months	Group III comparison between 4 and 12 months
Shape of the papillae	T Test for 2 Dependent Means	t	-2.236	-1.581	-1.581
		p	.075	.17	.17
		Significance at $p < .05$	not significant	not significant	not significant
Gingival recession	Kruskal-Wallis test	t	39	39	39
		p	1	1	1
		Significance at $p < .05$	not significant	not significant	not significant
Labial bone plate thickness	Mann-Whitney U-test.	The critical value of U at $p < .05$ is 5	18	18	18
		Significance at $p < .05$	not significant	not significant	not significant
Labial bone plate vertical resorption	Mann-Whitney U-test.	The critical value of U at $p < .05$ is 5	18	18	18
		Significance at $p < .05$	not significant	not significant	not significant

radiologist having over 20 years of experience, with a two weeks' interval. No significant changes were found in the thicknesses of the labial bone plate, which also did not show any vertical resorption in any of the cases in this study, which meant that the socket shield was able to maintain the labial plate of bone as if no tooth extraction was done.

DISCUSSION

This study used the socket shield technique as a new maneuver to stop maxillary anterior alveolar bone loss, 3 different implant systems were placed immediately after extraction with a bone graft placed in the intervening space between the implant and the socket shield. Unassisted socket healing in the form of an extraction socket receiving an immediate implant with neither a bone graft nor a socket shield, serving as the negative control, was not included for ethical reasons.

Gharpure and Bhatavadekar [1] histologic study of the socket-shield technique documented rapid bone loss, failure of osseointegration, formation of cementum, and a periodontal ligament-like fibrous tissue on implant surfaces in proximity to the shield which resulted in weakening in the biologic proof of principle of this technique. Heggeler et al [10] further added that solid conclusions about socket preservation after teeth extraction in humans are difficult to make because dimensional changes following bone resorption may still lead to a change in the socket height and width.

However, several other studies were in favor of the socket shield technique; Gluckman et al [3] in a 100 patient case series reporting on implant survival with the socket-shield technique found comparable survival rate to conventional delayed and immediate implants at mid-term follow-up with rare complication rate. Siormpas et al [4] further added that the socket shield increases the durability of the implant service by preserving their surrounding tissues. Also, Barakat et al [5] found that this technique maintained the buccal bone plate, and Mitsias et al [6]

human histologic study proved that this hypothesis was valid for immediate implants in function with no assistance of other ridge augmentation techniques.

The third generation bioactive glass, calcium phosphosilicate, utilized in this study was proven to result in vital bone formation after a 4 to 5 months healing period and tended to increase over time as found by Kesmas et al,[15] Kotsakis et al, [17, 18] and Gonshor et al [19] who reported that this relatively fast healing may provide a clinical advantage for implant osseointegration. In addition, the findings of Bembi et al [20] revealed that the bioactive calcium phosphosilicate was biocompatible and safe to use without causing any inadvertent tissue response or antigenic reaction for the treatment of intra bony defects once good oral hygiene and inflammation-free periodontal tissue were maintained in the postoperative phase. These findings were further confirmed by Mahesh et al [21, 25] and Babbush and Kanawati [22] who have shown that this bioactive glass paste consistency allowed faster and proper filling of the peri implant defects.

In this study, stabilization of the graft material by placing a contoured healing abutment was recommended by Tarnow et al [2] as it was able to minimize the facial- palatal dimensional changes of sockets receiving immediate implants, Sarnachiaro et al [32] and Harshakumar et al [58] further added that this approach maintained the gingival architecture and helped produce a better emergence profile for better esthetics of the definitive restorations.

Three dental implant systems were used in this study, the Biohorizon Laser-Lock, Nobel biocare Nobel Active, and the Adin Touareg-S implants, all have achieved good primary stability, successful osseointegration, and none of them was lost during the whole period of the study.

The success of Biohorizon implants immediate placement in the first group of the current work was also reported by Farronato at al [31] who used the same type of implants in thirty-nine patients that had more significant clinical attachment level and less peri-implant crestal bone loss than the other 38 non-Laser-Lok implants. Additionally, in two studies by Guarnieri et al [33, 35] it was found that the laser-micro grooving surface on this implant neck module provided better soft tissue attachment and reduced peri-implant bone loss in anterior maxilla immediate implants which make it a predictable option for well-selected patients. Similarly, the same results were obtained by Mangano et al [36] and Becker et al [38] in studies having no control group and comprising a larger number of patients respectively.

In agreement with Singh et al [41] the Adin Touareg-S dental implants used for group II in this study were also reported as reliable treatment option for patients requiring immediate implant placement, further the ability of Adin implants to obtain good bone anchorage and primary stability was reported by Alam et al, [45] whereas secondary stability achieved by these implants was referred by Jain and Gaur, [46] and Guastaldi et al [47] to its surface modified plasma treatment which enhanced the bone remodeling compared to their control group.

Kielbassa et al [48] and Arnhart et al [51] reported similar results about the Nobel Active implants, used in the third group of this study, in having stable levels of soft tissues and bone for 12 months after loading. The same conclusions were made by Cristalli et al,[52] Kan et al, [53] Moretto et al, [55] and Bell and Bell [56] who reported that with proper selection of patients, and meticulous surgical and prosthetic protocols, Nobel Active implants can achieve the desired primary stability in fresh extraction sockets and long term soft and hard tissue dimensional stability as compared to the conventional delayed placement of the dental implants. however, Cosyn et al [49] reported that the immediate Nobel Active implants placement is not recommended for daily practice as it had mid-facial recession and resulted in compromised esthetics in 8 of the carefully selected 17 patients, who received this treatment by

experienced clinicians.

This study also used screwed rather than cemented definitive prostheses, Shadid and Sadaqa [81] reported that each of these methods of retention has its own merits for being used in certain clinical scenarios, however, Wittneben et al [82] reported that screw-retained prostheses had less technical errors, and in another research [84] recommended to use the screw retained principle to avoid an additional risks of cement contaminants, which were reported by Francis and Pillai [83] to significantly increase the onset of vertical bone loss.

The CBCT used in this study has become frequently used in clinical research, however, Molen [66] emphasized that CBCT studies making small measurements are liable to misinterpretation due the reduced image resolution as compared to that of periapical radiography that was further found by Dave et al [63] to be better at diagnosing a peri-implant defects than the CBCT when the peri-implant space was 0.35 mm or smaller. On the other hand, and in accordance with the methods and results of the current work, several other studies used the CBCT for evaluations of labial alveolar bone thickness and corresponding vertical resorption as measured from the implant shoulder to the alveolar ledge such as that of Miyamoto and Obama, [64] or simply the mean gain in labial plate thickness such as that of Sarnachiaro et al, [32] and Leung. [65] Furthermore, Timock et al [67] and Kamburoglu et al [71] investigated the accuracy and reliability of CBCT images through comparisons with direct measurements, and concluded that CBCT measurements did not differ significantly from direct measurements. Based on these studies, it was concluded that the CBCT was a reliable method for evaluation of post-operative results, and also a preoperative analysis tool as recommended by El Nahass and Naiem. [75]

In conclusion, the socket shield technique was found to maintain the pre-operative dimensions of the labial plate of bone and its overlying soft tissues with improved and maintained pink esthetics with the 3 different dental implant systems used, in addition, the custom made healing abutment helped the maintenance of interdental papillae and the production of an emergence profile which can provide long-term esthetic benefits. However, this technique required careful patients' selection, proper treatment planning and follow-up, and is considered highly sensitive.

RECOMMENDATIONS

After conducting this study, the followings can be recommended:

1. Longer clinical follow-up periods and comparison with negative control groups.
2. The use of this technique in restoration of multiple teeth and in situations where the implants are subjected to different loading conditions such as beneath over dentures.
3. The provision for the use of double socket shields.

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