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LABIAL BONE PRESERVATION USING THE SOCKET SHIELD TECHNIQUE IN IMMEDIATE IMPLANT PLACEMENT WITH AND WITHOUT STICKY BONE GRAFT IN THE JUMPING DISTANCE A RANDOMIZED CONTROLLED CLINICAL TRIAL

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ABSTRACT

Background: Tooth extraction is one of the most widely performed procedures in dentistry, and it has been historically well documented that it can induce significant dimensional changes of the alveolar ridge. Implants placed in this manner, are advocated to preserve soft tissue form and contour, preserve bone dimensions, reduce the period of edentulism, reduce the overall treatment time and to optimize esthetic results. **Aim of the Work:** The primary objective of this study was the radiographic evaluation of the changes in height, thickness and density of the labial plate of bone and soft tissue changes after immediate implant placement performing the Socket- Shield Technique with and without using sticky bone graft one day postoperative and after 6 months. **Patients and Methods:** This prospective study included twenty patients who were categorized randomly into two groups; **group A**: cases were subjected to socket shield procedure followed by sticky bone graft, immediate implant placement and immediate implant loading and **group B**: cases were subjected to socket shield procedure followed by immediate implant placement and immediate implant loading without sticky bone graft. **Results:** Bone thickness was significantly higher in group A than group B immediately after implant placement and postoperatively and was significantly higher immediately after implant placement compared to postoperatively in group A and group B. Bone height was comparable between both groups immediately after implant placement and postoperatively with insignificant variation between immediately after implant placement and postoperatively in both group A and B. Bone density was significantly higher 6 months postoperatively when compared to baseline values in both group A and B. Bone density increased in both group A and B but the increase in density (mean difference) was significantly higher in group A compared to group B. **Conclusion:** It concluded that socket shield technique combined with sticky bone immediate implant placement is a viable technique to achieve osseointegration without any inflammatory response. Socket shield technique followed by sticky bone had superiority in preserving bone thickness.

KEYWORDS: Labial Bone Preservation, Socket Shield Technique, Immediate Implant Placement, Sticky Bone Graft, Jumping Distance.

INTRODUCTION

Tooth extraction is one of the most widely performed procedures in dentistry, and it has been historically well documented that it can induce significant dimensional changes of the alveolar ridge. Dental implants are frequently used to replace missing anterior teeth, tooth loss due to trauma, or teeth removed due to defective restorations at the time of tooth removal. Implants placed in this manner, either with or without direct immediate loading, are advocated to preserve soft tissue form and contour, preserve bone dimensions, reduce the period of edentulism, reduce the overall treatment time and to optimize esthetic results **(Araujo et al., 2005).**

Beyond measurement of implant survival, there is few data concerning the fate of the buccal plate after implant placement in sites where teeth have been recently extracted. The concern here is for architectural changes in the alveolar bone following extraction and subsequent to implant placement. Unanticipated and excessive tissue changes can result in unacceptable esthetic deficits that range from soft tissue asymmetry to facial tissue discoloration to marked tissue dehiscence and abutment or implant exposure **(Chen et al., 2009).**

Alveolar resorption has been characterized as an inevitable and progressive process that occurred rapidly following tooth extraction. Remarkable changes in the

maxillary alveolar ridges following the extraction have been reported **(Schropp et al., 2003).**

After tooth extraction, the marked changes in alveolar bone appear to be strongly linked to the loss of periodontal ligament and the consecutive trauma in particular at the buccal bone plate. Thus, it can be assumed that root retention may have an influence on the occurring resorption process **(Arau´jo et al., 2009).**

The loss of a tooth starts with remodeling reaction as part of the healing process, causing various degrees of alveolar bone resorption, especially affecting the buccal lamella: The periodontal membrane of the tooth is the primary source of vascularization for the bundle bone. Therefore, extraction compromises this part of the alveolar bone to such an extent that the buccal lamella is insufficiently nourished, leading to its total or partial resorption **(Arau´jo et al., 2009).**

With the root submergence technique (RST), submucosal root retention can virtually eliminate bone resorption. Based on this concept, the retention and stabilization of the coronal and buccal bundle bone and the retention of the periodontal membrane by retaining a coronal tooth fragment (so-called "socket shield"), including adequate blood supply, can be expected **(Salama et al., 2007).**

Implant placement and restoration to replace single or multiple teeth in the esthetic zone is an especially challenging area for the clinician, particularly in sites with multiple missing teeth and with deficiencies in soft tissue or bone. Preservation or creation of a soft tissue scaffold needed to create the illusion of a natural tooth is often challenging and difficult to achieve **(Magne et al., 1993).**

Growth factors appear to have an important function in repairing or generating damaged tissue. It is known that platelets release high quantities of growth factors. Several techniques to collect platelet aggregate have been utilized to accelerate tissue healing in dental and medical field **(Marx et al., 1998).**

A new concept has been demonstrated since 2010 for fabricating growth factors-enriched bone graft matrix (also known as "sticky bone") using autologous fibrin glue. Sticky bone helps to stabilize bone graft in the defect, and therefore accelerates the process of tissue healing and minimizes bone loss during healing period **(Kim, 2015).**

AIM OF THE STUDY

The aim of the present study was to evaluate radiographically the changes in height, thickness and density of the labial plate of bone and papilla height after immediate implant placement performing the Socket-Shield Technique with and without using sticky bone graft one day postoperative and after 6 months as a primary objective.

Clinical evaluation of soft tissue after immediate implant placement performing the Socket- Shield Technique with and without using sticky bone graft after 6 months as a secondary objective, these are plaque index, bleeding index and probing depth.

SUBJECTS AND METHODS

Sample selection and assignment

Twenty patients were included in this prospective study and recruited from the outpatient clinic of Oral Medicine, Periodontology and Oral Diagnosis department, Faculty of Dentistry, Ain Shams University. The proposal was reviewed by the faculty's research ethics committee and the patients were fully informed about the nature of the study. A written informed consent was obtained from all patients. The predicted sample size (n) was a total of (20) cases i.e. (10) for each group. Sample size calculation was performed using G* Power version 3.1.9.2.

Inclusion Criteria

Male and Female, age group between 18 and 45 years old, medically free, maxillary esthetic zone extended to the second premolar with healthy roots, good oral hygiene, indication of tooth extractions: untreatable caries, non restorable tooth, remaining root or in case of endodontic failure, type I Socket According to **Elian et al. (2007)** simplified classification for extraction sockets. (The facial soft tissue and buccal plate of bone are at normal levels in relation to the cement-enamel junction of the pre-extracted tooth and remain intact post extraction).

Exclusion Criteria

Patients taking drugs affecting bone metabolism for the past six months eg. cyclosporine, methotrexate, synthetic retinoids, smoker, pregnancy and lactation, thin biotype gingiva, acute infection, swelling and pus discharge, chronic active periodontal disease, vertical and horizontal root fracture, dehiscence or fenestration of the labial plate of bone, gingival recession, presence of parafunctional habits, the vulnerable group; prisoners and mentally ill.

By using a specific computer software, the twenty patients were randomly allocated either in group A or group B: group "A": ten subjects were subjected to socket shield procedure followed by sticky bone graft, immediate implant placement and immediate implant loading, group "B": ten subjects were subjected to socket shield procedure followed by immediate implant placement without sticky bone graft.

Preoperative Evaluation

Full clinical examination (Plaque index, Bleeding index, Probing depth) for the tooth were measured at baseline **(Fig.1)** to monitor the gingival condition and oral hygiene during period of follow up.

Cone Beam Computed Tomography (CBCT)* was performed to assess the bone volume available for

implant placement, presence of any periapical pathosis, dehiscence or fenestration of the labial plate of bone and assessment for any vertical or horizontal fracture of the remaining root.**(Fig. 2)**

The following CBCT machine protocol was used for all the scans of the study: tube voltage: 120 kVp, milliampere: 37.07 mAs, voxel size: 0.25 mm, scanning time: 26.9 seconds, field of view: 6 cm Height X 16 cm Diameter.

The implant system

JDEvolution Plus+* with diameters (3.7) and length (11.5& 13 mm). It has exclusive internal hex connection with lead-in bevel, it has an expanding tapered inner body design with apical cutting blades and self-cutting capacity that make it possible to achieve high primary stability and reduce stress concentration on crestal bone volume around the implant neck for stable hard and soft tissues.

Methods of evaluation

Radiographically

One day postoperative CBCT was performed to measure thickness, height and density of existent labial plate of bone and papilla height at baseline. Six months postoperative CBCT was performed to measure the changes in thickness, height and density of the labial plate of bone and papilla height.

Radiographic parameters

Bone thickness: The labial bone plate thickness was measured from the implant shoulder to the labial bone crest at baseline and postoperative after 6 months for each implant.

Bone height: The labial bone plate height was measured from implant shoulder to the tip of labial bone crest by drawing a horizontal line crossing the implant shoulder and a horizontal line crossing the tip of labial bone crest then the distance between the two horizontal lines measured by connecting both lines with a perpendicular line.

Bone density: The labial bone density of each implant was measured using the CBCT software at baseline and postoperative after 6 months follow up period. The mean densities and the standard deviations of each area were calculated automatically by the software in Hounsfield unit.

Clinical parameters

Plaque index, bleeding index, probing depth were measured after 6 months.

Surgical Procedure

Group "A"

Subjects were instructed to rinse with Hexitol** mouth wash before surgery. Surgical area was swabbed with Betadine*** mouth gargle, autologous fibrin glue (AFG) to make growth factors-enriched bone graft matrix (sticky bone) is prepared at the same time. Before surgery is performed, 20-60CC of patient's venous blood is taken from patients' vein in patient's forearm, and the blood is transported to non-coated vacutainers to obtain autologous fibrin glue (AFG), which will make sticky bone. The blood in the test tubes is centrifuged at 2400-2700 rpm using specific centrifuge with a motor turning at alternated and controlled speed for 12 minutes **(Fig.3).** The centrifugation time for AFG varies from 2-12 minutes. To get higher growth factors, the centrifuge is stopped after 2 minute- centrifugation and take AFG tube out of the centrifuge first. The non-coated tube shows 2 different layers **(Fig.4).** The upper layer is autologous fibrin glue (AFG) layer and red blood cell is collected in bottom layer which will be discarded. The upper AFG is obtained with syringe and mixed with xenograft particulate bone powder**** and allows for 5-10 minutes for polymerization in order to produce sticky bone which is yellow colored **(Fig.5),** after local anesthesia*, the hopeless tooth is split supragingival and the crown fragment is carefully dislocated and removed using a suitable instrument. The root is separated vertically with tapered stone in a ratio between 1:3 labial and 2:3 palatal **(Fig.6).** Using the implant drill, the palatal part of the root is hollowed to facilitate its removal without dislodging the labial part **(Fig.6),** the height of the buccal socket shield is reduced to half the distance between the free gingival margin and the alveolar crest**,** using the implant drill to make the osteotomy site for immediate implant** placement palatal to the labial shield leaving a jumping distance between the shield and the implant **(Fig.7),** the gap was then filled with sticky bone graft material **(Fig.8),** the healing abutment was immediately placed and Cross mattress suture was done for soft tissue closure using 4/0 polypropylene suture*** **(Fig.9),** the subject delivered a Zirconium final prothesis **(Fig.10,11).**

Group "B"

Surgical procedure was done the same as group A, but without preparation and application of sticky bone graft **(Fig.12-18).**

Postoperative care and follow up.

All patients received postoperative antibiotic (Amoxicillin/ Clavulanic acid*) 1gram every 12 hours orally for 5 days, and non-steroidal anti-inflammatory analgesic (Ibuprofen**) 400mg every 8 hours orally for 5 days. Patients were instructed to follow oral hygiene measures and to use chlorohexidine 0.2%*** mouthwash for 2 weeks. Sutures were removed two weeks post - operative. All patients were clinically evaluated at 1 week, 2 weeks, 1 month and 6 months post operatively.

Figure 1: Pre-surgical photographs showing remaining root of previously root canal treated right central incisor (Case of group A).

Figure 2: Pre-surgical radiographs showing remaining root of right central incisor with intact labial bone plate with no evidence of dehiscence, fenestration or infection (Case of group A).

Figure 3: A specific centrifuge with a motor turning at alternated and controlled speed from 2,400 to 2,700 rpm for 12 minutes.

Figure 4: Showing non coated test tube shows two different layers. The upper layer is AFG layer and the bottom layer is accumulation of red blood cell which will be discarded.

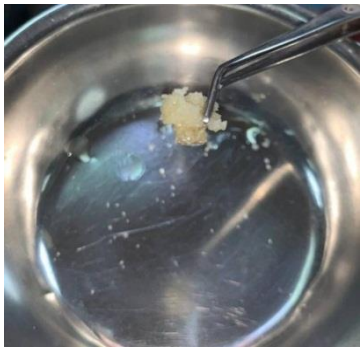

Figure 5: AFG mixed with xenograft particulate bone powder and allows for 5-10 minutes for polymerization in order to produce sticky bone which is yellow colored.

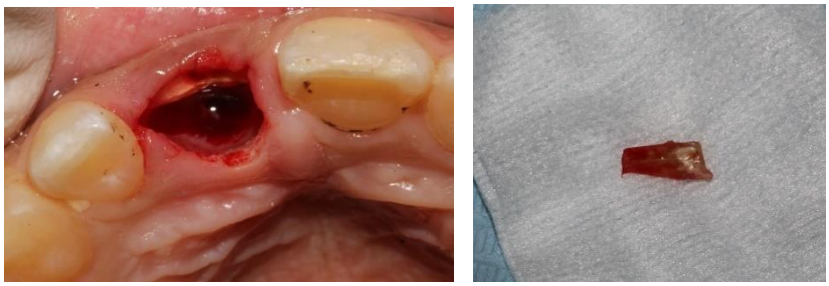

Figure 6: Extraction of palatal part and preparation of labial shield (Case of group A).

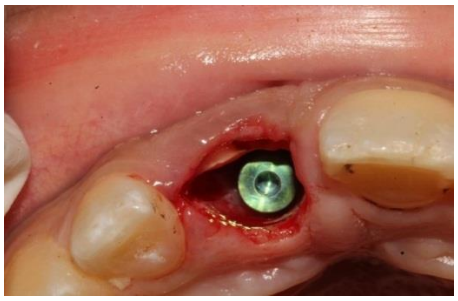

Figure 7: Implant engaging palatal wall leaving a jumping gap between the implant and the labial shield (Case of group A).

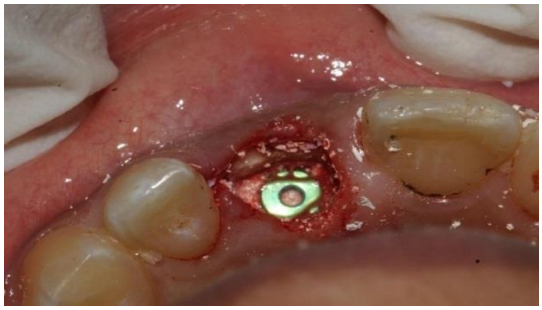

Figure 8: Filling the gap between implant and labial shield with sticky bone (Case of group A).

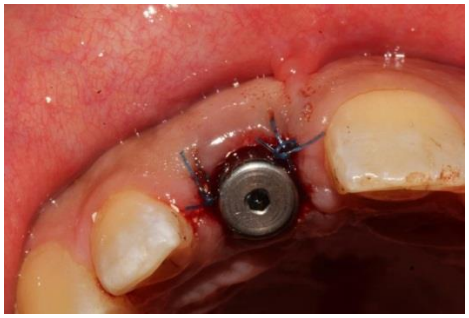

Figure 9: Healing abutment and suturing (Case of group A).

Figure 10: Healing after 6 months (Case of group A).

Figure 11: Occlusal view of Zirconium final prosthesis (Case of group A).

Figure 12: Pre-surgical photographs showing remaining root of previously root canal treated right central incisor (Case of group B).

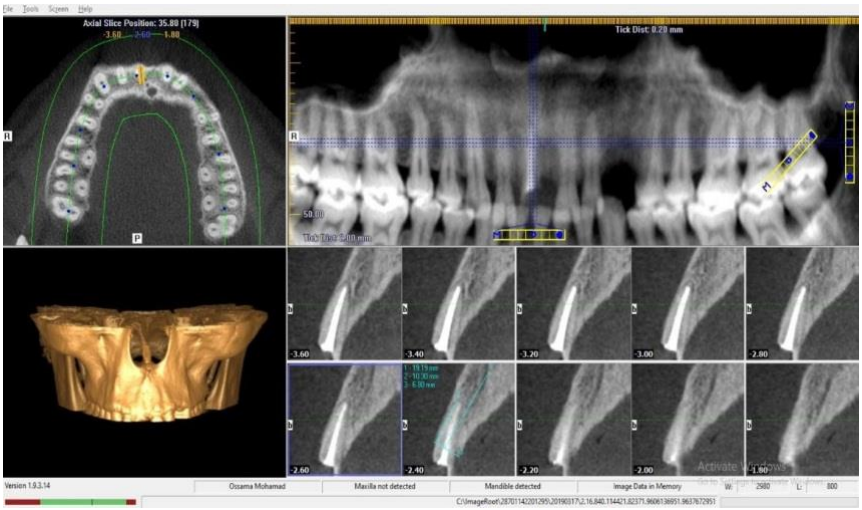

Figure 13: Pre-surgical radiographs showing remaining root of right central incisor with intact labial bone plate with no evidence of dehiscence, fenestration or infection (Case of group B).

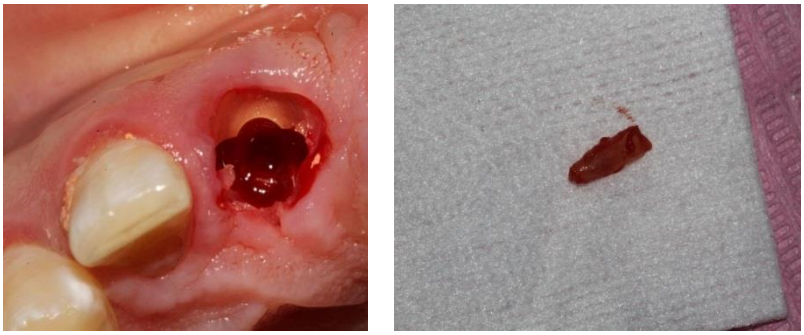

Figure 14: Extraction of palatal part and preparation of labial shield (Case of group B).

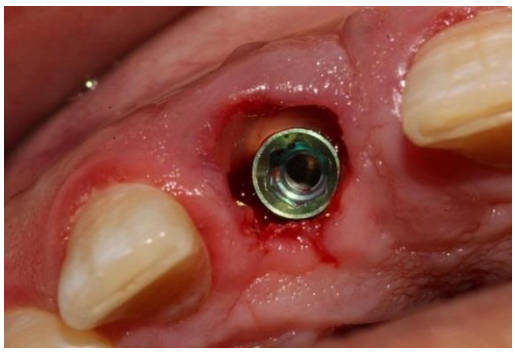

Figure 15: Implant engaging palatal wall leaving a jumping gap between the implant and the labial shield (Case of group B).

Figure 16: Healing abutment and suturing (Case of group B).

Figure 17: Healing after 6 months (Case of group B).

Figure 18: Occlusal view of Zirconium final prosthesis (Case of group B).

Statistical analysis

Statistical analysis was performed using the SPSS (Statistical Package for the Social Sciences) version 25 (IBM Inc., Chicago, IL, USA). Categorial variables were expressed as frequency and percentage and were statistically analyzed by Chi-square test. A two-tailed P value ≤ 0.05 was considered statistically significant.

RESULTS

Twenty patients were included in this prospective study. They were divided into two groups. One case from group B had failed 48 hours after surgery, patient was recalled and the labial part of remaining root was extracted, the socket was cleaned and grafted with xenograft particles, 3 months later delayed implant was done.

- **Bone thickness**

1- Intergroup comparison

The bone thickness ranged from 2.6-3.2 mm with a mean (±SD) of 2.83±0.18 mm in group A and ranged from 1.4-2 mm with a mean (±SD) of 1.73±0.21 mm in group B immediately after implant placement (at base line). This difference was statistically significant with P- value = 0.001. The bone thickness ranged from 2.2-2.8 mm with a mean (±SD) of 2.43±0.22 mm in group A and ranged from 1.2-1.5 mm in group B with a mean (±SD) of 1.36±0.11 mm postoperatively. This difference was statistically significant with P- value < 0.001**. (Table 2).**

2- Intragroup comparison

Bone thickness was significantly higher immediately after implant placement (at base line) compared to postoperatively in group A with P value =0.001. Bone thickness was significantly higher immediately after implant placement compared to postoperatively in group B with P value =0.001. The mean difference in bone thickness was significantly higher in group B compared to group A with P value < 0.001. **(Table 2)** i.e. the bone thickness decreased significantly in group B more than group A.

Table 1: Bone thickness (mm) of the studied groups.

		Group (A) (n=10)	Group (B) (n=10)	P# value
Immediately after implant placement	**Mean ± SD**	2.83±0.18	1.73±0.21	**0.001***
	Range	2.6-3.2	1.4-2	
Postoperatively(6 months)	**Mean ± SD**	2.43±0.22	1.36±0.11	**<0.001***
	Range	2.2-2.8	1.2-1.5	
P##		**0.001***	**0.001***	--
Mean difference		0.047	-0.370	**<0.001***

P#:P value between group A and group B, P##: P value between immediately after implant placement and postoperatively in the same group.

- **Bone height**

1- Intergroup comparison

The bone height ranged from 12.9-16.2 mm with a mean (±SD) of 14.18±1.36 mm in group A and ranged from 12.8-15.9 mm in group B with a mean (±SD) of 13.9±1.08 mm immediately after implant placement (at base line). This difference was statistically insignificant with P value = 0.617. The bone height ranged from 12.6-15.2 mm with a mean (±SD) of 13.75±1.13 mm in group A and ranged from 12.6-15 mm in group B with a mean (±SD) of 13.49±0.7 postoperatively. This difference was statistically insignificant with P value =. 0.543. **(Table 4).**

2- Intragroup comparison

Bone height was insignificantly different between immediately after implant placement (at base line) and postoperatively in both group A and group B with P value =0.158 and 0.156 respectively. The mean difference in bone height was insignificantly different between both groups with P value=0.945. **(Table 4).**

Table 2: Bone height of the studied groups.

		Group (A) (n=10)	Group (B) (n=10)	P# value
Immediate implant placement	**Mean ± SD**	14.18±1.36	13.9±1.08	0.617
	Range	12.9-16.2	12.8-15.9	
Postoperatively (6 months)	**Mean ± SD**	13.75±1.13	13.49±0.7	0.543
	Range	12.6-15.2	12.6-15	
P##		0.158	0.156	--
Mean difference		- 0.430	- 0.410	0.945

P#:P value between group A and group B, P##: P value between immediately after implant placement and postoperatively in the same group.

- **Bone density**

1-Intergroup comparison

The bone density ranged from 656-820 with a mean (±SD) of 722±66.99 in group A and ranged from 500-785 in group B with a mean (±SD) of 660.4±108.72 immediately after implant placement (at base line). This difference was statistically insignificant with P value=0.145. The bone density ranged from 700-1111with a mean (±SD) of 886.9±149.61 in group A and ranged from 647-958 in group B with a mean (±SD) of 827.5±135.61 postoperatively. This difference was statistically insignificant with P value=0.365. **(Table 5).**

2- Intragroup comparison

Bone density was significantly higher postoperatively when compared to baseline values in both group A and B with P value =. 012 for group A and P value <0.001 for group B. The mean difference in bone density was significantly higher in group a compared to group B with P value 0.012 **(Table 5).**

Table 3: Bone density of the studied groups.

		Group A (n=10)	Group B (n=10)	P# value
Immediate implant placement	**Mean ± SD**	722±66.99	660.4±108.72	0.145
	Range	656-820	500-785	
Postoperatively	**Mean ± SD**	886.9±149.61	827.5±135.61	0.365
	Range	700-1111	647-958	
P##		**0.012***	**<0.001***	
Mean difference		176.90	167.10	**0.012***

P#:P value between group A and group B, P##: P value between immediately after implant placement and postoperatively in the same group.

DISCUSSION

After tooth removal, alveolar ridge alterations occur naturally leading to bone loss, the main attributing factor to this negative effect is the loss of periodontal attachments, and trauma accompanying tooth removal **(Elsharkawy et al., 2021)**.

Marked dimensional reduction of the alveolar ridge width and height represents a physiologic sequela after tooth extraction. This resorption was pronounced clinically and histologically at the buccal part of the ridge more than the lingual part **(Abdelraheem et al., 2022)**.

Several approaches have been described for contouring the socket alterations caused by tooth extraction: implant placement directly after extraction; positioning of the implant on the palatal wall; performing the surgery using the flapless technique to maintain vascularization; and using soft tissue or bone grafts to maintain the dimension of the ridge by socket augmentation **(Passoni et al., 2016)**.

Reduction of blood supply is a critical reason for alveolar bone resorption. The end osseous marrow in cancellous bone, periodontal ligament, and labial periosteum are the 3 main sources of blood supply to the alveolar ridge **(Guo et al., 2018)**. Bone plates on the anterior region of maxillary arch are thin and primarily composed of cortical bone lacking vascular supply. Thus, post extracted alveolar ridges in aesthetic areas are more vulnerable to resorption. Upon extraction of the tooth, blood supply from the periodontal ligament is destroyed **(Sanz et al., 2010)**.

For cases treated with socket-shield technique (SST), the labial part of the periodontal ligaments can be preserved and residual labial periodontal ligaments can connect dental cementum with peri-implant bone; thus, peri-implant tissue can become more like normal periodontal tissues, and can better protect against soft tissue retreat **(Hürzeler et al., 2010)**. To minimize therapeutic trauma, increase patient satisfaction, and reduce post-surgical bone resorption, SST was applied to the residual labial site of the tooth fragment, and platelet-rich fibrin (PRF) was used around the shield to promote bone healing **(Abdullah et al., 2022)**.

At immediate implant sites, the functionally loaded periodontal ligament can be destroyed during tooth extraction, which could lead to severe gingival recession **(Guo et al., 2018)**.

On the basis of the root submergence technique (RST), which was first documented in 1960s, **(Salama et al., 2007)**, the SST was first reported by **(Hürzeler et al., 2010)**; this provided an alternative idea for immediate implant sites at anterior aesthetic regions. With the goal of preserving, rather than augmenting, peri-implant tissue, SST indicated that the root should be sectioned in its mesiodistal direction, after atraumatic removal of the palatal root segment; thus, the labial part of the root segment is shaped and remains in the alveolar socket, while the remaining labial root should be 1 mm above the alveolar crest, and shaped carefully to approximately 2 mm **(Guo et al., 2018)**.

The root section, together with the attached periodontal ligaments, was used as a socket shield. In this process, the alveolar bone and periodontal ligament were protected, the implants were able to contact with the residual labial root directly, and the periodontal root-PDL system was retained in the labial portion of the implant site. Compared with alveolar bone, the residual

root was more resistant to resorption, and the functional PDL could connect the residual root with the gingival margin; this connection was much more rigid than the implant-gingival interface of normal peri-implant tissue. Thus, the implant-root-PDL-gingiva system could help prevent the retreat of peri-implant gingiva **(Ryan and Kohles, 2022)**.

Hence, the primary objective of the current study was the radiographic evaluation of the changes in height, thickness and density of the labial plate of bone and soft tissue changes after immediate implant placement performing the Socket- Shield Technique with and without using sticky bone graft one day postoperative and after 6 months.

This prospective study included twenty patients who were categorized randomly into two groups; **group A**: cases were subjected to socket shield procedure followed by sticky bone graft, immediate implant placement and immediate implant loading and **group B**: cases were subjected to socket shield procedure followed by immediate implant placement and immediate implant loading without sticky bone graft.

In this study, cases with maxillary esthetic zone extended to the second premolar with healthy roots were included as suggested by **(Abd-Elrahman et al., 2020) (Ghoneim and Abdel Rasoul, 2022)** who also included maxillary esthetic zone from second bicuspid to second bicuspid.

Cases taking drugs that affect bone metabolism and those with chronic active periodontal disease or vertical and horizontal root fracture, dehiscence or fenestration of the labial plate of bone and gingival recession were excluded as **(Abd-Elrahman et al., 2020)**.

Autologous fibrin glue (AFG) was used in the present study to make growth factors-enriched bone graft matrix (sticky bone) as it accelerates the process of tissue healing and minimizes bone loss during healing period. Moreover, fibrin network entraps platelets and leukocytes to release growth factors that accelerate bone regeneration and soft tissue regeneration. In addition, fibrin interconnection also minimizes soft tissue ingrowth into sticky bone graft **(Aboelela et al., 2022)**.

Zirconium as a final prosthesis was used as it causes less inflammation after implantation than titanium alloy **(Kozakiewicz et al., 2021)**.

Moreover, CBCT was performed to measure thickness, height and density of existent labial plate of bone at baseline and papilla height as it provides information on bone loss on buccal and lingual aspects of the implants as well as mesial and distal aspects due to its three-dimensional nature.. Moreover, CBCT can be used easily especially with inclined palatine vault of the mouth without causing patient discomfort or gagging reflex as periapical radiographs do. CBCT also has no magnification or distortion as panoramic radiographs **(Raes et al., 2013)**.

In this regard, **(Aboelela et al., 2022)** also used CBCT scans at three different times; preoperatively, 2 days and 6 months after the surgery when the mean bone gain was calculated. Moreover, The use of CBCT in measuring bone resorption around implants was recommended by other investigators **(Elsyad and Khirallah, 2016)**.

Followed up was done for 6 months, this was also done by **(Abdelraheem et al., 2022)** who followed-up cases after 6 months postoperatively to evaluate immediate implant placement with socket-shield technique versus using bone graft filling the jumping gap in the form of sticky bone in maxillary aesthetic zone

In the present study, after implantation there are anatomical structures to be examined in a single tooth extraction site in the esthetic zone, these anatomical structure are; thickness, height and density of existent labial plate of bone at baseline and papilla height as suggested by (**Ghoneim and Abdel Rasoul, 2022)**.

In addition, plaque index, bleeding index, and probing depth were assessed. These indices were also evaluated by **(Park et al., 2019)** and **(Shawky and Khair Allah, 2020)**.

Regarding the bone thickness, at baseline as well as after 6 months, the bone thickness was higher in group A than group B with a statistical significant difference. Bone resorption happened in both groups after 6 months. Results showed that the bone loss was significantly higher in group B than group A. This could be explained on the basis of the role of sticky bone that was used in group A filling the gap between implant and labial shield. The sticky bone is rich in growth factors that enhance bone apposition and decrease signs of inflammation. Moreover fibrin interconnection in sticky bone minimizes soft tissue ingrowth into graft. Also the measurements of bone thickness at baseline were significantly higher in group A than group B, that could affect the results after 6 months postoperatively.

These results were comparable to **(Kapa et al., 2022)** who found that the treatment with sticky bone in cases with gingival recession in maxillary esthetic zone resulted in the radiographic increase in labial plate thickness reflected clinically as increase in gingival thickness.

In addition, **(Wang et al., 2021)** demonstrated that the use of sticky bone for guided bone regeneration (GBR) was associated with significantly more labial bone thickness than other groups were that treated with particulate bone substitutes.

In contrast to the current results, **(Abdelraheem et al., 2022)** showed that there was no significant difference in

bone thickness between the socket shield and sticky bone groups.

In addition, **(Abd-Elrahman et al., 2020)** revealed that the socket shield and sticky bone techniques were comparable regarding the bone thickness.

The superiority to maintain the bone thickness in group A could be the result of the combination of socket shield technique and using sticky bone together; SST preserves periodontal attachment, including cementum, periodontal ligament and bundle bone, and utilizing the sticky bone in the jumping gap which contain growth factors that accelerate the process of tissue healing and minimize bone loss during the healing period.

Furthermore, **(Bäumer et al., 2017)** reported that the socket shield technique offers reduced invasiveness at the time of surgery and high esthetic outcomes with effective preservation of facial tissue contours.

Regarding bone height, results showed that at baseline and after 6 months bone height was comparable between group A and group B with no significant difference with P value 0.617 and 0.543 respectively. Bone resorption happened in both groups but bone height was insignificantly different between baseline and after 6 months in both group A and B with P-value 0.158 and 0156 respectively. Results showed that the bone loss was insignificantly different between both groups with P-value 0.945.

These results were in agreement with **(Abd-Elrahman et al., 2020)** demonstrated that there was no significant difference between sticky bone group and socket shield group regarding the bone height.

In the same context, **(Rupawala et al., 2020)** showed insignificant difference in bone height between immediately after implant placement and postoperatively after treatment with sticky bone and reported that the positional stability of sticky bone prevented fibrous in-growth, which reduced alveolar resorption and helped in preserving the postoperative bone height. Hence, the present study affirms the positive role of sticky bone in maintaining the dimensions of the bone.

On the other hand, **(Abdelraheem et al., 2022)** found that the bone height was significantly higher in sticky bone group compared to socket shield group for period of 6 months (P=0.039).

In addition, **(Atef et al., 2021)** found that the socket shield yielded significantly less bone resorption compared to conventional immediate implant placement with simultaneous grafting of the buccal gap**.**

That could be explained as that conventional immediate implant placement failed to prevent the resorptive changes and also may contribute to more vertical and horizontal bone resorption especially at the buccal aspect but the socket shield technique showed more stability in preserving bone volume horizontally and vertically.

In this study, results showed that bone density at baseline and after 6 months in both group A and B were comparable with no significant difference with P-value 0.145 and 0.365 respectively. Bone density was significantly higher 6 months postoperatively when compared to baseline values in both group A and B with P-value 0.012 and <0.001 respectively. Bone density increased in both group A and B but the increase in density (mean difference) was significantly higher in group A compared to group B with P-value 0.012.

Ozdemir et al., 2013 reported similar results regarding mean values of bone density for grafting material, there was marked increase in bone density after six months follow up. The use of PRF can increase the quality (density) of the newly formed bone and enhance the rate of new bone formation and this may be explained by the presence of concentrated growth factor in the PRF.

Similar to our results, **(Abdullah and Abdelmabood, 2020)** showed that regarding bone density, there was a statistically significant decrease at 3 months and highly statistical significant decrease at 6, 9, and 12 intervals in autogenous bone ring transplant group compared to the immediate implantation in sticky bone group.

Growth factors present in sticky bone might stimulate the deposition of precursors of bone-forming cells and hinder the osteoclast activity. Consequently, deposition of sticky bone acts as a nidus for the accelerated conversion of osteoid into mineralized tissue having superior bone density and elimination of lamina dura within 4–8 weeks as compared to inferior bone density seen on the control site for the same time interval **(Rupawala et al., 2020)**.

In contrast to this study, **(Jeyaraj and Chakranarayan, 2018)** observed that the radiological evidence of bone density of the extraction sockets at the end of 8 weeks was inferior in the PRF treated patients.

Regarding papilla height, results showed that at baseline and after 6 months bone height was comparable between group A and group B with no significant difference with P value 0.320 and 0.077 respectively. Papilla height was insignificantly different between baseline and after 6 months in both group A and B with P-value 0.072 and 0.325 respectively. Results showed that the mean difference of papilla height was insignificantly different between both groups with P-value 0.945.

In this study, probing depth at baseline as well as after 6 months in both group A and B was comparable with no significant difference between the two groups with P-value 0.227 and. 0114 respectively. Probing depth in group B was significantly lower after 6 months

compared to baseline with P-value 0.015, on the other hand there was no significant difference comparing probing depth after 6 months to baseline in group A with P-value 0.269. The amount of decrease in probing depth (mean difference) was insignificantly different between both groups with P-value 0.556.

(Kapa et al., 2022) found that after 6 months follow up, there was a decrease in probing depth postoperatively than immediately after implant placement in sticky bone treated patients.

(Dsa et al., 2020) showed that there was a reduction in the probing depth from baseline to 9 months ($p< 0.001$) postoperatively in sticky bone group.

Moreover, **(Barakat et al., 2017)** conducted their study on 20 patients to evaluate the socket shield technique clinically and radiographically as a new modality for immediate implantation in comparison to the conventional technique. The result showed that peri implant probing depth of the socket shield group improved significantly over the healing period. This reduction of peri-implant probing depth indicates improvement of the collagen fibers arrangement and density around dental implants preventing loss of osseointegration and periimplantitis and the shield of root did not interfere with it.

Concerning bleeding index, results demonstrated that bleeding index was the same at baseline as well as after 6 months (median = 0) in both groups with P-value =1.

In the same context, **(Kaur Singh, 2022)** showed that bleeding index using SST showed better results compared to conventional technique. This is an important factor related to bone loss and esthetics. Furthermore, as retained root improves periodontal measurement, hence reduces bone loss and inflammation of soft tissues.

Abdelrahman et al., 2020 in a study comparing SST versus conventional immediate implant placement found superiority of SST in results regarding pink esthetic score PES and related that to the superiority of SST in maintaining the labial bone plate thickness and height that support the soft tissue and maintain papilla height and contour.

CONCLUSION

Within the limitation of this study, it concluded that socket shield technique combined with sticky bone immediate implant placement is a viable technique to achieve osseointegration without any inflammatory response. Socket shield technique followed by sticky bone had superiority in preserving bone thickness.

It can be concluded that: socket shield technique combined with sticky bone immediate implant placement is a viable technique to achieve osseointegration without any inflammatory response, socket shield technique combined with sticky bone had superiority in preserving bone thickness better than socket shield alone, socket shield technique combined with sticky bone immediate implant placement showed that there is no significant difference regarding maintaining bone height compared to socket shield alone, socket shield technique combined with sticky bone had superiority in enhancing bone density more than socket shield alone, socket shield technique combined with sticky bone immediate implant placement showed that there is no significant difference regarding maintaining papilla height compared to socket shield alone, regarding clinical parameters, socket shield technique combined with sticky bone showed no significant difference in results compared to socket shield alone.

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