

COMPARISON OF SOCKET PRESERVATION USING SOCKET SHIELD TECHNIQUE WITH AUTOGENOUS DENTIN GRAFT VERSUS ALLOPLAST GRAFT MATERIAL (CLINICAL STUDY)

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ABSTRACT

INTRODUCTION: "After extracting teeth, both remarkable resorption in the alveolar bone and an obvious reduction have occurred in the labial bone plate as a consequence of the blood supply deficiency that happens especially when the periodontal ligaments are lost. Therefore, to keep the periodontal ligaments preserved, a socket shield technique with autogenous dentine was introduced.

AIM OF THIS STUDY: Radiographic evaluation of a combined technique using autogenous dentin graft with socket shield for pre-implant socket preservation

Patient and method: Eight patients received socket preservation using alloplast with socket shield on one side and received socket preservation using Autogenous dentin graft with socket shield on the contralateral side (split-mouth Design). CBCT was done before surgery and after 3 months to evaluate bone density and bone height.

RESULT: The density of the recently formed teeth bone was significantly greater in the study group participants ($P=0.011$) than in the control one. However, when comparing its height among the 2 groups, there was no significant difference that could be considered.

CONCLUSION: Autogenous Dentin proved to be a promising graft together with using the socket shield protection approach that helped in preserving the socket, especially in the esthetic zone. Therefore, further clinical studies could be performed to compare autogenous dentin and other bone substitutes.

KEYWORDS: Extraction, socket preservation, alloplast, Dentin graft, socket shield.

RUNNING TITLE: Comparison between dentin and alloplast grafting material

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INTRODUCTION

One of the greatest problems in implant dentistry remains is achieving full preservation or complete soft tissue restoration of the tooth peri-implant, especially those involving the areas of aesthetic importance, and can often only be done in selected cases (1).

These notable changes can happen as a result of many influencing factors that accompanied the tooth extraction process, for example, any mechanical trauma that may occur and the numerous microorganisms to which the oral cavity is socket (2).

The process of resorption can be most affected by any loss that may occur either in the periodontal ligament or the bundle bone as they play a major role (3). Whatever target is achieved by root retention, the main obvious concept for pursuing it is that it works by keeping not only the periodontal

attachment maintained, including cementum but also the periodontal ligament and the bundle bone. A special technique that is called "socket shield" is developed to retain the periodontium that is present within the marginal region of the formed implant oral side during the partial root retention process (4). In regards to many preclinical studies, the buccal periodontal tissue preservations, especially that involving the bone plate, have been already reported on a historical basis together with the volumetric stability extent of the periodontal tissue structures documentation, particularly due to the implementation of the "socket shield" concept. Those previous outcomes have been recently published along with the initial clinical case study reports which are documented during application (follow-up investigation took 6 months and 1.5 years) (4,5).

Horowitz et al. (2012) reported in their study the fact that applying the procedures required for alveolar ridge preservation may decrease the ridge resorption occurrence when compared with keeping the fresh alveolar sockets with no graft material insertion. However, if it is inadequately performed, an obvious deformity will happen and as a result, this will be a significant obstacle that will be a barrier to aesthetic, phonetic, and also functional results (6).

In the dentistry field, the primary source for bone grafting can be the use of allogeneic bone and other synthetic mineral artificial materials. Considering the high demand for good bone harvesting, freshly used autogenous bone graft is still recognized as the gold standard due to the presence of bioactive cells which show not only non-immunogenic and non-pathogenic properties but also high inductive matrix characteristics (7).

Several animal investigations have been developed and exploited many approaches to preserve the alveolar bone as much as possible through processing the bovine dentin, so it can be used as a particulate and sterile grafting material (8,9). It is also obvious that the teeth will become grafts that will be gradually replaced by bone (10).

An innovative and extremely biocompatible option for jaw replacement is autogenous odontogenic materials.(11)

The organic component of autogenous teeth provides a variety of growth factors that support bone regeneration and healing, while the inorganic component serves as a scaffold to preserve volume and permit donor cell adhesion and proliferation(11). Bone reconstruction may be encouraged since dentin and bone have similar chemical compositions(11). A biocompatible and biodegradable bioceramic, β -tricalcium phosphate (β -TCP) has been widely considered as a safe and effective alternative to autograft for bone reconstruction due to its excellent osteoconductivity(12).

Moreover, Schmidt-Schultz and also Schultz (2005) have both detected the conserved growth factors, that remain intact, in the collagenous extracellular matrix that is found in the ancient human bone and teeth (13).

The major aim of this ongoing study is to assess how the efficiency of using alloplast with a socket shield against an Autogenous dentin graft with socket shield, is in socket preservation.

MATERIALS AND METHODS

This study has been registered at, clinicaltrials.gov and granted an ID number: NCT05047887

Study design

The type of this study is a controlled clinical trial with a 1:1 allocation ratio. (split-mouth design)

It was set up and reported according to the CONSORT guidelines.

Eight patients underwent socket preservation using alloplast grafting with socket shield on one side and

Autogenous dentin graft with socket shield on the other side of the esthetic zone of the maxilla.

Setting and allocation

Participants were recruited from the Oral and Maxillofacial Department outpatient clinic, Faculty of Dentistry, Alexandria University, Egypt.

Sample size estimation

Sample size was estimated based on confidence level= of 95% and study power= of 80%. The mean \pm SD cortical bone height three months after using autogenous bioengineered injectable PRF – tooth graft was 4.22 ± 0.976 .(12) When beta tricalcium phosphate with type I collagen (β -TCP-CI) was placed, the mean \pm SD bone height was 7.18 ± 2.68 .(15) Sample size was calculated to be 8 patients.

Eligibility criteria

Inclusion criteria (14,16)

- Regardless of gender, age ranges from 20 to 45 years old.
- One or more tooth/teeth cannot be restored in the anterior area of maxilla aesthetic regions (incisors) on both sides.
- Intact labial periodontal tissues.

Exclusion criteria(17)

- Any medical history that contraindicates oral surgical treatment (uncontrolled/untreated diabetes mellitus, immuno-compromised status, radio/chemotherapy of the oral and maxillofacial region,
- Untreated periodontal disease.
- Vertical or horizontal root fractures.
- Tooth /teeth with external or internal resorptions.
- Teeth were free from any apical infections or draining sinuses.

Grouping

Group 1: 8 patients received both autogenous dentin graft combined with socket shield technique.

Group 2: 8 patients received both alloplast grafts combined with socket shield technique.

Pre-surgical Phase

A detailed history was taken from each patient who includes the following: name, phone number, place of living, job, and medical history.

Each patient was examined for caries examination, gingival health, and mobility or pain of tooth to be extracted (Fig. 1A). Radiographic examination of the patient included panoramic radiograph for evaluation of sinus proximity and possibility of inserting a stable implant. A cone-beam CT was done as a baseline evaluation of the buccal bone thickness, and buccolingual dimensions of the tooth to be extracted.

Preoperative preparation of the patient included scaling and polishing if needed.

Surgical procedure⁽¹⁴⁾

Routine disinfection was done, and local dental anesthesia (Artinibsa 1:100,000 epinephrine, Inibsa Company ,Spain) was administered.

Labial shield preparation

In both study groups, the hopeless tooth crown, if found present, was extensively irrigated and meanwhile decoronated using chamfer diamond bur and also a large-head round diamond bur, as far as reaching bone crest level. This step was skipped in already decoronated teeth due to caries or fracture.

Moreover, the root was set in two halves along its long axis, one is buccal and the other one is palatal, preserving the coronal and middle part of the buccal shield, while the apical part was removed using a long shank fissure bur.

The Microperiosteome was applied to retrieve any palatal root fragment carefully, while the long shank fissure bur was used to shape the buccal root remaining fragment into a thinner form and make it slightly concave. To maintain the buccal root fragment resistant to any fracture and resorption, its thickness was adjusted to be about 2 mm.

The coronal section that is related to this shield was beveled until reaching a lingual slope so a better profile emergence can be achieved along with a considerable large head round diamond bur.

The socket shield was investigated if there is any immobility with a probe to ensure that future complication of shield migration is avoided. (Fig. 1B)

Dentin Graft preparation⁽¹⁷⁾

After the palatal section was removed, a tungsten bur and endodontic files were used to remove any found caries, restorations, cementum, pulp tissue, periodontal ligament (PDL), and even the calculus that may be present in the extracted part.

The involved tooth was crushed subsequently for 3–10 seconds using a pulverized blade grinder at 25,000 revolutions per minute. Special sieves were used to sift the teeth particles into sizes ranging from 300 to 1200 microns. To eliminate any remains of soft buccal tissue, germs, and layer of smear, the selected tooth crushed particles were put in a sterile container and submerged with 70% ethanol and also 5% Peracetic acid for 10 minutes (defatting and sterilization).

After that, the involved tooth pieces were demineralized for 20 minutes with 2 percent Nitric acid (HNO₃) to reveal the dentin organic matrix.

To restore the pH equilibrium to 7.4, the sorted dentin that was free of any bacterial particle was washed twice using phosphate-buffered saline for 5 minutes each time. (Fig. 2)

The demineralized autogenous dentine graft chips were utilized to keep the socket maintained and protected. (Fig. 1C)

Alloplast application

The contralateral socket was filled with alloplast (β -TCP-CI) (Bicera, alloplast, Taiwan). (Fig. 1C)

In both groups, a collagen membrane(Biodegradable barrier membrane, GCM1020 10 x 20 thickness, Dentium, Genoss Co, Ltd, Suwon, South Korea) was applied to cover the preserved socket followed by suturing using vicryl 4 zero suture.

Statistical Analysis of the Data

All the inserted data are fed up into the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) The collected qualitative data were represented in numerical values and percentages. To verify all data distribution, the Shapiro-Wilk test was used and the data were expressed in range (minimum and maximum), mean, standard

deviation, and median respectively. Moreover, the significance of the results which are collected was judged at the 5% level.

The used tests were

1 - Paired t-test

For comparing two periods quantitative data variables that are normally distributed.

2 –Wilcoxon signed ranks test

For comparing two periods quantitative data variables that are abnormally distributed periods.

RESULTS

Bone Density (BD)

Data of the bone density were collected at three areas of the root: at crest of the bone, at the middle, and at the apex, both preoperatively and after 3months just before implant placement (Table 1).

Study group

Pre-surgical, the mean of BD was 1130.5 HU with a minimum recorded value of 890.0 HU and a maximum recorded value of 1334.0HU. After 3 months, the found mean bone density was 1408.0 HU with a minimum recorded value of 1231.0 HU and a maximum recorded value of 1607.0 HU.

This difference of pre-surgical BD values was statistically significant with a p-value <0.05.

Control group

Pre-surgical, the mean BD was 1076.5 HU with a minimum recorded value of 820 HU and a maximum recorded value of 1291.0 HU. After 3 months, the formed mean bone density was 1233.0 HU with a minimum recorded value of 980.0 HU and a maximum recorded value of 1669.0 HU.

This difference of pre-surgical BD values was statistically significant with a p value <0.05.

The percentage of increase did not show a significant difference between the two groups.(Table 1).

Labial Bone Level (LBL)

Data were recorded considering the marginal bone height, particularly those found occupying the mesial, middle, and distal areas of all labial parts, and a clear line was drawn among the cemento-enamel junction of the adjacent buccal teeth that are surrounding our socket shield to the meant tooth and three lines were drawn to mesial, middle and distal aspects of the labial part.

Study group

The mean Difference of LBL was -0.17 ± 0.08 with a minimum recorded value of -0.31 and a maximum recorded value of 0.06 .

This difference of LBL values was statistically no significant with a p value >0.05.

Control group

The mean Difference of LBL was -0.21 ± 0.10 with a minimum recorded value of -0.38 and a maximum recorded value of -0.06 .

During this study, we calculated the marginal bone level average mean values and their standard deviation both preoperatively and after graft placement by 3 months (Fig. 4), (Table 2).

This difference of LBL values was statistically no significant with a p value >0.05.

Table (1): Comparison between study and control sides according to bone density (n = 8)

Bone Density	Study side	Control side	Test of Sig.	p
Preoperative				
Mean ± SD.	1134.0 ± 164.8	1076.6 ± 144.0	t= 1.827	0.110
Median (Min. – Max.)	1130.5 (890.0 – 1334.0)	1076.5 (820.0 – 1291.0)		
Pre-implant (post-grafting)				
Mean ± SD.	1419.6 ± 144.4	1259.5 ± 205.7	t= 3.410*	0.011*
Median (Min. – Max.)	1408.0(1231.0 – 1607.0)	1233.0 (980.0 – 1669.0)		
p₀	0.001*	0.008*		
Increase				
Mean ± SD.	285.6 ± 150.9	182.9 ± 140.1	Z= 1.820	0.069
Median (Min. – Max.)	252.5 (145.0 – 619.0)	165.5 (-1.0 – 462.0)		
% increase				
Mean ± SD.	26.71 ± 16.93	17.19 ± 12.17	Z= 1.820	0.069
Median (Min. – Max.)	21.63 (11.37 – 62.65)	17.29 (-0.09 – 38.28)		

SD: Standard deviation t: Paired t-test
 Z: Wilcoxon signed ranks test
 p: p value for comparing between study and control sides
 p₀: p value for **Paired t-test** for comparing between Preoperative and Pre-implant (post-grafting)
 *: Statistically significant at p ≤ 0.05

Table (2): This table represents a comparison among the study and control sides depending on the change in the recorded bone height values (n = 8)

Difference in bone height pre-operatively and 3 months after bone graft (mm)	Study side	Control side	Z	p
Mean ± SD.	-0.17 ± 0.08	-0.21 ± 0.10	0.6	0.5
Median (Min. – Max.)	-0.18 (-0.31 – -0.06)	-0.21 (-0.38 – -0.06)	31	28

SD: Standard deviation Z: Wilcoxon signed ranks test
 p: p value for comparing between study and control sides

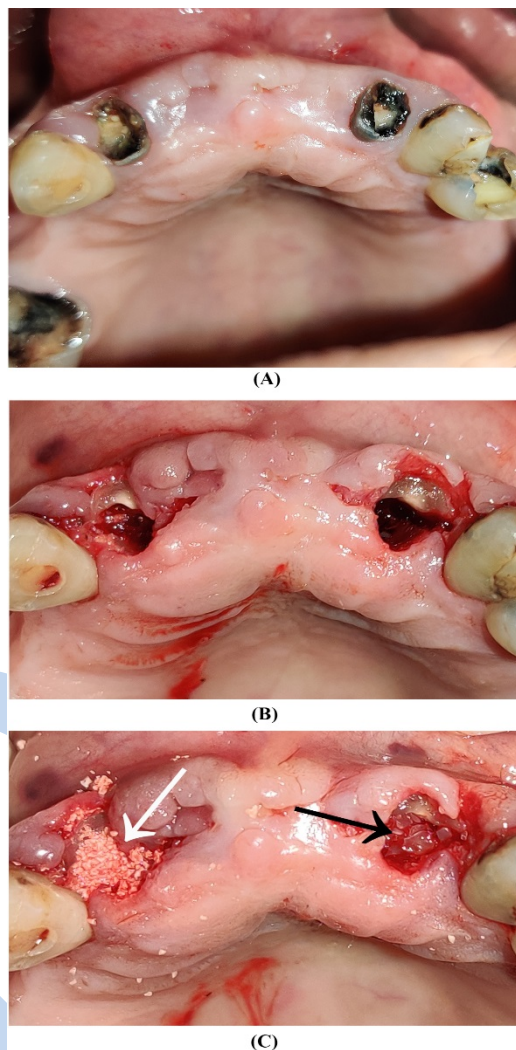


Figure 1: A) Presurgical examination. B) Final labial shield preparation and sockets are ready for graft placing. C) Graft material in sockets (the black arrow refers to dentin graft while white graft refers to alloplast).

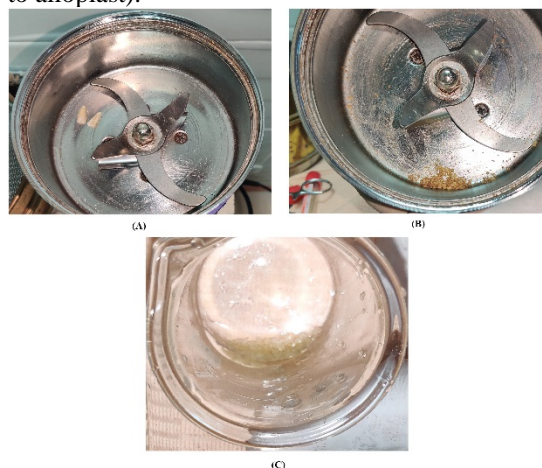


Figure 2: Dentin preparation

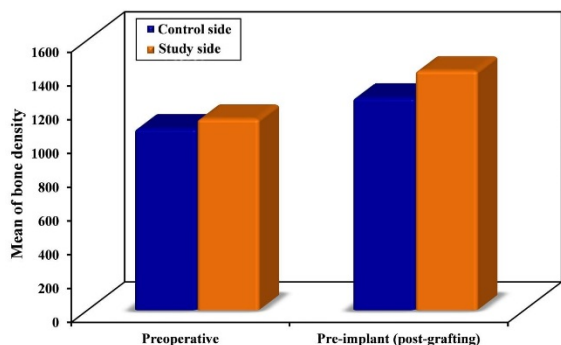


Figure 3: Comparison between study and control sides according to bone density (n = 8).

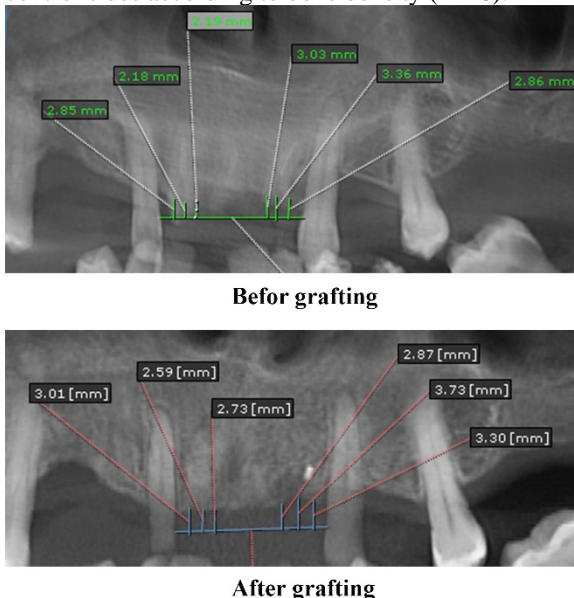


Figure 4: Labial bone level measurement.

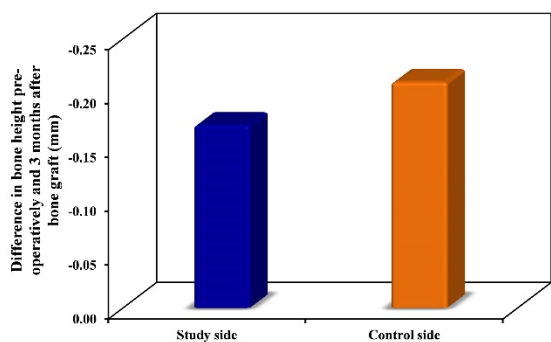


Figure 5: Comparison between study and control sides in accordance to change in bone recorded height (n = 8).

DISCUSSION

The reduction recognized in the buccal bone wall thickness and also the observed periodontium loss caused by tooth extraction have both made a significant effect on the implant placement process, especially in the aesthetic zone (18,19). Due to the successful extraction of the present growth factors and bone morphogenic proteins

(BMPs) from mammalian teeth, researchers have been encouraged to use tooth-derived substances in the development of bone substitution (20-23). Some studies have encouraged the concept of considering the teeth as stem cells and growth factors carrier. In regard to the tooth-derived regenerative techniques which are implemented in tissue engineering, many published findings have encouraged the researchers to develop a new protocol for processing a bone graft material depending on the use of extracted teeth (24).

In this study, combined socket shield technique and autogenous dentin graft were used for socket preservation of maxillary teeth in the esthetic zone. Radiographical assessment is done at the implant placement time to evaluate the new bone that is formed in the preserved sockets.

During our study, the socket shield technique (SST) was put under testing for the grafting of the palatal socket to see its effect on bone formation. The alloplast bone graft was used for the control side and the Dentin graft was used for the study side. The labial shield was reduced to about 2 mm in thickness and its height was flushed at the level of the labial bone.

By doing a split-mouth design in this study to control confounding variables such as age, sex, and local tissue conditions, this study was able to unify the kind of operation and patient characteristics. Graft site bone density was remarkably enhanced during this study as mean bone density was 1134.0 ± 164.8 Hounsfield units (H.u.) in study group and 1076.6 ± 144.0 in control group before grafting the extraction location. Three months post the graft placement process, the average bone density was 1419.6 ± 144.4 Hounsfield units (H.u.) in the study group and 1259.5 ± 205.7 in control group.

This noticeable escalation in bone density displays new successful bone creation, mineralization, remodeling, and also maturation particularly at the site of the graft, as well as improved peri-implant bone architecture and mineralization, resulting in increased primary implant stability and also osseointegration establishment (25).

The existence of odontoclast cells on the external face of the autogenous fresh demineralized tooth (A.F.D.T) graft occupying Howship's lacunae, where resorbed regions of the graft were replaced by freshly formed bone, indicates biodegradation of (A.F.D.T) (25).

This is because both autogenous bone and (AFDT) grafts have a modest crystalline structure and may be composed of further calcium phosphate minerals such as tricalcium phosphate (β -TCP), ACP, and OCP, which are un identical but highly similar to the minerals that are found in human bone (26).

The (AFDT) grafts will resorb at a slower pace than the autogenous applied bone grafts so this will enable vascularization, new bone creation, remodeling, and also bone maturation particularly at

the graft placement region without making a great transplanted volume loss (27).

In contrast to the existing current grinding mechanisms which are implemented during tooth graft preparation, we discovered that the study grinding approach was much safer than that one applied in Murata et al technique, where liquid nitrogen was almost used to make the teeth freeze, so it can then be crushed with a pestle and mortar (20).

The defatting, demineralization, and sterilizing measures were carried out with readily accessible commercial products that were generally harmless to handle and can be prepared to the appropriate concentrations at a cheap expense (28).

Our method proves its effectiveness cost-wise when it is compared with the other commercial systems, for example, the KometaBio® Smart Dentine Grinder (Komrtabio company, Fort Lee, NJ, USA), which involves the use of not only a disposable grinding chamber but also pre-packaged defatting and sterilizing chemical products that must be refilled (29).....

Unless Smart dentine grinder® includes both grinding measures together with sieving measures to save time, however, this approach results in the formation of calcified autogenous dentine grafts because this lacks the demineralization phase, which is required for subjecting the organic dentine matrix and growth factors that encourage bone formation. Therefore, more time is consumed for the bone to heal efficiently (20,29).

Because of its high oxidizing activity, which oxidizes, the application of Peracetic acid inhibited the microbial development within the (AFDT) graft through oxidizing microorganisms' outer cell walls (30).

Proteins will be denatured, cell wall permeability will be disrupted, and sulfhydryl and sulphur linkages in proteins, enzymes, and other metabolites will be oxidised, resulting in fast deactivation of microorganisms (31).

Nonetheless, Peracetic acid effectively inactivates a wide range of microorganisms including gram-positive bacteria, gram-negative ones, fungi, and yeasts within 5 minutes after exposure even with organic materials existence (31).

CONCLUSIONS

Autogenous Dentin graft could be a promising graft for socket preservation after extraction, and further clinical studies could be performed to compare autogenous dentin and other synthetic bone substitutes.

CONFLICT OF INTEREST

The authors declare that they have no financial or personal conflicts of interest.

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