ORIGINAL STUDY

Evaluation of the Effect of Dentin Graft Versus Autogenous Bone Graft on the Maxillary Alveolar Ridge Augmentation

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Abstract

Purpose: The purpose of this study was to assess the effect of dentin graft and autogenous bone graft on maxillary socket preservation. Patients and methods: A total of 10 patients, who had un-restorable maxillary teeth, and had a plan for implant placement after extraction, were included in this study. They were divided based on the type of graft used in socket preservation into two equal groups, group A: the extraction sockets in five patients were grafted with dentin graft and then covered with collagen membranes. Group B: the extraction sockets of the remaining five patients were grafted with autogenous bone graft before being covered with collagen membranes. Preoperatively and 6 months after surgery, Cone-beam computed tomography was utilized to assess the vertical alveolar bone alterations and horizontal bone alterations at three different levels. Results: There was no statistically significant difference in vertical bone loss and horizontal bone loss at three different levels in both groups after 6 months, there was a dramatic decrease in post-extraction bone loss. Conclusion: Dentin grafting has similar clinical and radiological results compared with those obtained using autogenous bone graft thus overcoming the limitations of autogenous bone graft.

Keywords: Autogenous bone graft, Dentin graft, Socket preservation

1. Introduction

Following tooth extraction, the alveolar ridge typically experiences volume loss and morphological alterations. The placement of an implant-supported crown may be difficult due to these alterations, which are frequently clinically significant. After extraction, maintaining the alveolar ridge reduces any residual ridge resorption, enabling the placement of an implant that satisfies both cosmetic and functional requirements [1].

Autogenous bone grafts, allografts, xenografts, and alloplastic materials are often utilized in dental treatment. The benchmark for treating alveolar bone deficiencies is autogenous bone grafting. They can induce osteogenesis, osteoinduction, and osteoconduction. They thereby promote quick healing without immunological rejection. Restricted donor locations, variable available bone volume, especially from intraoral sites, and potential donor site morbidity are some of the limitations that have been identified.

Dentin and bone are both mineralized tissues with chemical compositions that are almost identical. They are made up of 70% hydroxyapatite, 2% non-collagenous proteins, 18% collagen, and 10% body fluid. The collagenous dentin matrix is identical to the bone matrix and can promote bone development. Many authors compared dentin graft with autogenous bone graft and reported that the materials used in dentin graft are thought to be biodegradable biomaterials with compact microporous and low crystalline structures. The BMPs in dentin and bone are also thought to be major stimulants with osteoinductive properties [2].

Therefore, the present randomized clinical comparative study aimed to assess the impact of dentin

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graft and autogenous bone graft on maxillary socket preservation.

2. Patients and methods

2.1. Study design and population

The current study involved 10 patients who had unrestorable maxillary teeth and had a plan for placing implants after tooth extraction.

Sample size: A total number of 4 is calculated using epicalc program version 1.02 assuming a power of 80% and alpha ¼ 0.05; where the attrition rate was adjusted to be 20%. The sample size is based on mean ± SD for difference of lingual bone height was (0.4 ± 1.68) at time of extraction was (8.54 ± 2.22) and after 4 months was (8.79 ± 2.73).

From December 2020 to September 2022, the patients were chosen from the outpatient clinic of the Faculty of Dental Medicine for Girls, Oral and Maxillofacial Surgery Department.

All patients received written informed permission (in the Arabic language) and were asked to sign it in line with the Declaration of Helsinki. The Research Ethics Committee (REC) gave its approval to a research proposal (code: REC-SU-23-03).

2.2. Inclusion and exclusion criteria [3]

All selected patients had un-restorable maxillary tooth/teeth that are indicated for extraction and had a plan for implant placement after extraction. All patients were systemically free so as not to affect bone healing or osseointegration and had good oral hygiene. In addition, patients were excluded if they had an acute Periapical infection or had any Parafunctional habits. Smokers, alcohol users, and patients taking any drugs that hinder the healing and formation of bone for instance immunosuppressant, corticosteroid, or bisphosphonate therapy also excluded.

Patients demographic data including age and sex were recorded. Two groups of patients were split randomly, each with the same number of patients (n ¼ 5). Group A: Socket preservation was performed by dentin graft and covered with collagen membrane. Group B: Socket preservation was performed by autogenous bone graft and covered with collagen membrane.

2.3. Patient management protocol

All patients of both groups were examined as follows:

(a) Comprehensive preoperative clinical intra- and extra-oral examinations were conducted to evaluate hard and soft tissue and teeth conditions as well as any signs and symptoms of infection.

(b) Cone-beam computed tomography (CBCT) was requested for preoperative planning and to evaluate alveolar bone height and width. CBCT was also carried out at 6 months postoperative to record the mean change in the height and width measurements. The horizontal alveolar bone width was measured subcrestal, while the vertical bone height was assessed by determining the length of a line that crosses the midline of the socket and parallel to its long axis.

(c) Postoperative complications including wound infection, graft exposure, and soft tissue dehiscence were also recorded immediately postoperative, after 1 week, 1, and 6 months.

2.4. Surgical procedures

Full mouth scaling was done for all patients before the surgery. In addition, they were instructed to maintain adequate oral hygiene measures. The surgery was performed under complete aseptic condition. The surgical sites were disinfected by 10% povidone-iodine antiseptic solution before giving local anesthesia (LA), which was achieved by infiltration technique, using Articaine hydrochloride (HCL) 4% with epinephrine 1:100,000. All patients were subjected to atraumatic extraction technique, followed by gentle curettage of the socket/s. Normal saline was used to irrigate the extraction sockets and then packed with gauze.

In group A: Using a surgical bur, the extracted teeth were cleaned, removing any remnants of the periodontal ligament, all cavities, restorative materials as well as any other debris, leaving only the cleaned teeth which were dried by air syringe, and then the teeth were grinded in the Smart Dentin Grinder (CT Dent, London, UK) according to the manufacturer instructions. The size of the resulting particles ranges from 300 to 1200 mm [3] (Fig. 1).

The particulate dentin were cleaned by Dentin Cleanser (0.5 M sodium hydroxide with 20% ethanol), decalcified by Ethylene-diamine-tetra-acetic acid (EDTA), and followed by Phosphate Buffered Saline (PBS) washing [3].

In group B: A crestal incision was done over the maxillary tuberosity. After periosteal reflection, utilizing a large trephine bur with external diameter of 8, bone was harvested from the tuberosity (Fig. 2). The osteotomized tuberosity bone was crushed using bone crusher (see Fig. 3).

Fig. 1. Photograph showing (a) the smart dentin grinder. (b) The resulting dentin particles.

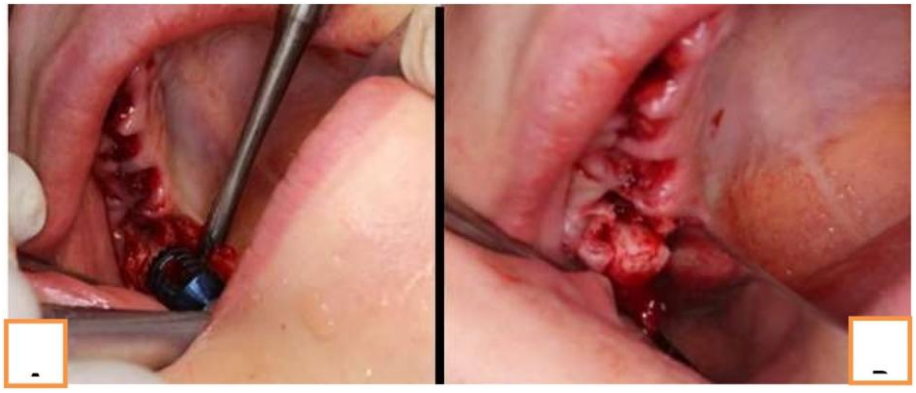

Fig. 2. Intraoperative photographs showing (a) trephine bur inserted over the tuberosity. (b) Surgical site after osteotomy.

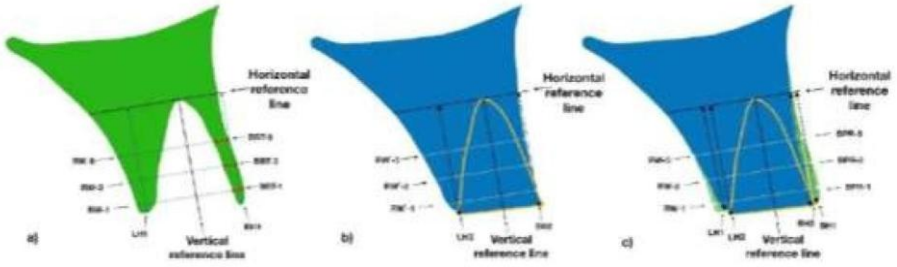

Fig. 3. Diagram showing the method of measurement at (a) Primary image (b) secondary image and (c) Superimposition between the two images.

In all patients, a mucoperiosteal envelope was created by detaching the soft tissues from the buccal and palatal sides of the alveolar ridge, graft materials were gently packed in the extraction sockets then collagen membrane was inserted under the periosteum. The extraction sites were sutured using 3-0 Vicryl sutures. After 6 months postoperative CBCT scans were ordered to evaluate linear bone changes.

Antibiotic therapy with 1 g of amoxicillin was prescribed every 12 h for 6 days. The patients were instructed to rinse every 8 h with a 0.2% chlorhexidine mouth rinse and to take ibuprofen 600 mg every 12 h for 3 days. All the patients returned at 7 and 14 days postoperatively for examination.

2.5. Statistical analysis

All collected numerical data were analyzed and represented as means, standard deviations, median, and ranges using IBM SPSS advanced statistics, version 23. In this study, vertical and horizontal bone changes were analyzed. The Shapiro-Wilk test was used for normality, while difference and association between groups were investigated by the *t*-

test in the case of normally distributed data. *P*-value was established to determine the statistically significant difference between the groups if a *p*-value less than or equal to 0.05 it is considered statistically significant.

3. Results

Ten patients (8 females and 2 males) were involved in the study. The average of patient age in group A was 30.0 11.7 years. The average of patient age in group B was 32.0 10.3 years.

All surgical procedures were performed successfully in all patients without intraoperative problems. Six months of follow-up was conducted on every patient. No problems followed the surgery in any of the cases where healing was uneventful except one case in group B who complained of pain and inflammation in the harvested site of bone graft one week post-operatively which was relieved by anti-inflammatory medication within 5 days.

3.1. Ridge height and width measurements

According to Pohl *et al*. [4], Ridge height and width measurements were acquired on the baseline and follow-up CBCT scans. Horizontal and vertical reference lines were determined on the baseline CBCT image and duplicated onto the follow-up CBCT image. The vertical reference line was outlined from the apex through the center of the socket and the horizontal reference line through the apex perpendicular to the vertical line. The ridge width was measured parallel to the horizontal reference at three different levels from the highest buccal ridge point on the secondary image. Dimensional ridge width changes were assessed based on the measurements performed at the baseline and after six months at three levels above the crest. Baseline mid-buccal and mid-palatal ridge heights and those during follow-up were measured from the most apical point of the alveolar socket parallel to the vertical reference line. The most coronal aspect on the buccal and palatal sides of the ridge at the secondary image was determined as the coronal reference point regardless of whether it was a cortical bone plate or grafting material still in the osseointegration phase.

3.2. Comparison between preoperative and postoperative radiographic results in both groups

In comparison between the two groups according to preoperative and post-operative differences of buccal and palatal bone height and bone width 3, 5, and 10 mm above the crest measures. The differences are statistically insignificant in all studied measures ($P > 0.05$). (Table 1) (Fig. 4).

4. Discussion

Resulting from bone resorption after extraction, the ridge's dimensions are significantly reduced. The highest rate of resorption occurs within the initial 3 months after extraction which makes implant placement during this time without augmentation of tissues, both soft and hard difficult.

It should be emphasized, however, that if the patient consents to process and utilize his or her teeth, using an auto tooth does not violate the law. A tooth does not cause issues even if the root rests in the alveolar bone unless it is contaminated by an infection. In many instances, residual roots can be intentionally kept in place to protect the alveolar bone [5].

Many authors have compared dentin grafting to autogenous bone grafting and found that the structures and physicochemical characteristics of dentin grafting are almost identical to those of autogenous cortical bones. Additionally, it is believed that dentin graft is a biodegradable biomaterial with a compact microporous and low crystalline structure [6,7].

Recently, Demineralized dentin was used as graft material, where the extracted tooth was sent to Tooth Banks to be crushed and subjected to dehydration, defatting and demineralization processes before being lyophilized, sterilized with ethylene oxide gas, then returned to the clinic or hospital. This process takes several days to weeks to be completed. In later studies, a more recent device (VacuaSonic) was used to produce demineralized dentin graft chairside, but the process takes a minimum of at least 2 h [8].

Table 1. Comparison between the two groups according to pre and postoperative measure differences.

	Group	Mean	SD	*P* Value
Bone height				
Buccal	A	−1.19	1.28	0.78
	B	−1.46	1.64	
Palatal	A	−1.92	1.99	0.13
	B	−0.43	0.17	
Bone width				
At 3 mm above	A	−2.36	1.15	0.099
the crest	B	−1.20	0.78	
At 5 mm above	A	−0.67	0.61	0.21
the crest	B	−1.31	0.84	
At 10 mm above	A	−1.17	1.30	0.92
the crest	B	−1.24	0.89	

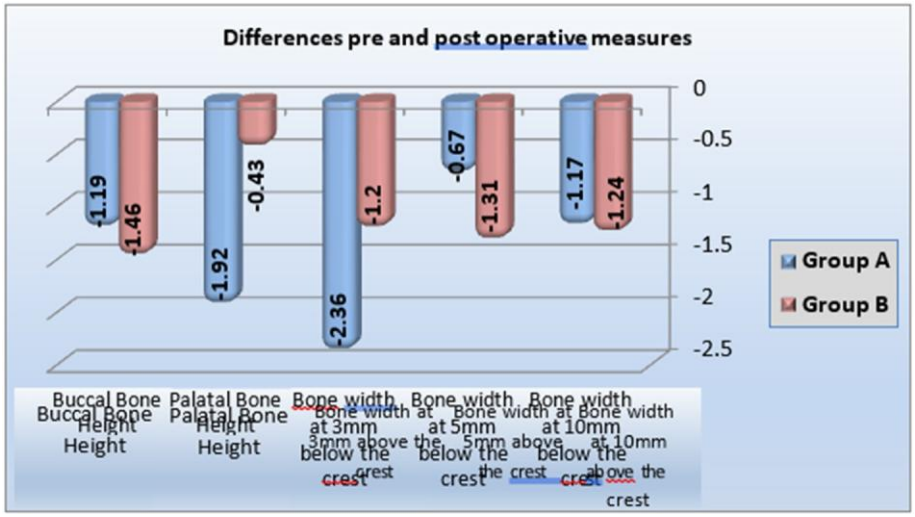

Fig. 4. Bar Chart representing the percent of means change in horizontal and vertical bone loss in both groups.

In the current study, the cleaned and dried teeth were ground using Smart Dentin Grinder, disinfected with dentin cleanser, decalcified with EDTA then washed with phosphate buffered saline to be ready for grafting. This process takes about 15e20 min. Therefore, the device provides time-saving procedure. In addition the grinder converts this biological waste into a precious graft material, which can compete with the gold standard of graft materials; autogenous bone graft [3].

A systematic review [9] revealed that the physiologic proportion of vertical dimension change ranged from 11 to 22%, whereas the proportion of horizontal dimensional change ranged from 29 to 63% at 6e7 months, with an average horizontal bone loss of 50%.

A clinical study on socket preservation using three clinical protocols leukocyte and platelet-rich fibrin (L-PRF) alone, L-PRF mixed with a bone xenograft, and bone xenograft alone-stated that the L-PRF group revealed the horizontal dimensional change was 38.3%, while the L-PRF plus bone xenograft group had smaller dimensional changes in the horizontal (18.9%) and vertical (11.42%) dimensions. However, none of the methods utilized in the three groups were able to fully make up for the changes that resulted from tooth extraction [10,11].

In the present study, the authors evaluated the horizontal bone loss after six months of socket preservation with dentin graft and autogenous bone graft at three different levels, this is coincident with Pohl *et al.* [4], who evaluated the horizontal bone changes after 4 months of socket preservation with dentin graft at 1, 3 and 5 mm below the crest. This method of measurement is more accurate than one-level measurement. In the present study, the dentin group revealed significant differences in horizontal bone loss at 3 mm above the alveolar crest, while at the remaining two levels, dentin group revealed a nonsignificant differences. This is in contrast to a clinical and radiographic study [12], which evaluated the effectiveness of autogenous dentin graft in socket preservation and revealed that the mean difference of alveolar ridge width between the preoperative and 6 months postoperatively at the three different levels was statistically significant.

In the present study autogenous bone group revealed significant differences in horizontal bone width at three different levels. This is coincident with a clinical study [13] which evaluated the effectiveness of autogenous bone graft in socket preservation and revealed that the mean difference of alveolar ridge width between the preoperative and 4 months postoperatively were statistically significant.

Regarding to the reduction of buccal and palatal bone height after six months of socket preservation, the dentin group revealed a nonsignificant bone reduction. In contrast a previous study [12] revealed significant differences in both buccal and palatal bone height reduction.

Regarding to buccal bone height, the autogenous bone group showed a nonsignificant difference in buccal bone height, in contrast to a previous study [13] which revealed a significant difference in buccal bone height reduction. This group also revealed a significant difference in palatal bone height after 6 months of socket preservation, similarly to a previous study which revealed a significant difference in palatal bone height reduction.

With comparing the results of the two groups we obtained that the difference was not statistically significant. This is coincident with a clinical study [6]

which compared dentin graft with autogenous bone graft and revealed a nonsignificant difference between both groups.

The key finding of this study is that the use of dentin graft had a positive effect on the reduction of postextraction bone resorption similar to the effect of autogenous bone graft overcoming the limitation of the autogenous bone graft so; it is recommended to be used for socket preservation procedures, as it preserves postextraction sockets dimensions. However, it was economically expensive, adding more costs to the operation.

4.1. Conclusion

Dentin grafting had a similar clinical and radiographic results compared with those obtained using autogenous bone graft thus overcoming the limitations of autogenous bone graft.

Ethics information

The Research Ethics Committee (REC) at Faculty of dental Medicine for girls gave its approval to a research proposal (code: REC-SU-23-03).

Biographical information

The study was done at the clinic of Oral and Maxillofacial Surgery Department, Faculty of Dental Medicine for Girls.

Funding

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Conflict of interest

There are no conflicts of interest.

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