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VALIDITY OF AUTOGENOUS DENTIN GRAFT IN FILLING THE JUMPING GAP IN IMMEDIATE DENTAL IMPLANT PLACEMENT IN ANTERIOR MAXILLA

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ABSTRACT

Objectives: The purpose of the present study was to evaluate the validity of using autogenous dentin graft to fill the jumping gap in immediate dental implantation of anterior maxilla. **Subjects and methods:** The study comprised fourteen patients seeking treatment for compromised anterior maxillary teeth. Two equal groups were randomly selected from the patients (7 in each group). In both groups, the patients have their offending teeth extraction with simultaneous immediate implantation. The gap around the implants were grafted with autogenous dentin in group1 and autogenous bone in group 2. All patients were clinically and radiographically evaluated for implant stability and the changes of bone density around implant. **Results:** In both groups, all implants showed acceptable primary stability with a significant improvement in secondary stability measured at 6 months postoperatively, no difference was found between groups. The mean value of bone density was significantly increased in both groups, no difference was found between groups. **Conclusion**: The use of autogenous dentin graft with immediate implantation offers a new promising safe, compatible, and effective method for managing the healing process around immediate dental implants placement.

KEYWORDS: Immediate implant; Jumping gap; Dentin graft; Autogenous bone

INTRODUCTION

Missing tooth/teeth in the esthetic zone has a passionate influence on the social and psychological health of patients [(1)]. Dental implants, fixed partial dentures, or removable partial dentures (RPDs) can be used to replace a single missed tooth. Each of these treatment options has its own advantages and disadvantages [(2)]. It has been suggested that removable partial denture is a quick, easy, conservative and less invasive treatment. But concurrently, patient discomfort is frequently associated with the RPD decision [(3-5)]. Fixed prosthodontics is not conservative due to the abutment teeth preparation, this may cause pulp damage of the teeth [(6)].

Dental implants are a well-recognized kind of therapy for lost teeth. Three alternative methods for the timing of dental implantation in accordance to extraction time could accomplish it. An implant placed in a fresh extraction socket was denoted as an immediate implant. Within eight weeks of the tooth extraction, an implant placed in the extraction socket was referred to as immediate-delayed, while an implant placed later was referred to as delayed implants [(7, 8)]. Before placing the implants, it was

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standard procedure to wait a few months following tooth extraction to allow the alveolar bone to recover [9].

The protocol of instantaneous implantation was designed in order to reduce treatment time and maintaining the integrity of soft tissues and alveolar bone. Crestal bone loss was observed to be lesser in implants placed immediately compared to implants placed later [10-12].

Immediate implantation has a problem in primary stability due to the discrepancy in size and form between the extraction socket and the implant, there is usually a space left the implant called jumping gap. An excessive jumping distance can cause a bony defect and bone resorption, which would reduce the stability of the implant. Implant stability is unaffected by a jumping distance less than 2 mm. It is recommending the usage of barrier materials and bone grafts when this distance is greater than 2mm[13-15].

To enhance osseointegration different graft materials are advocated to fill this gap. These include autogenous bone grafts, allografts, xenografts and alloplastic grafts [13,14]. Owing to their osteoinductive, osteogenic, and osteoconductive properties as well as their capacity to hasten healing; autogenous bone graft are regarded as the gold standard. Unfortunately, its usage was limited by the creation of donor areas that resulted in secondary defects, increased trauma, and complexity, as well as the small amount of harvested bone that was collected

Both xenogenic and allogenic bone can cause immunological rejection or infection. Their clinical application is limited by their poor degree of patient acceptability, high treatment costs, and limited osteogenic impact [16, 17].

To avoid these disadvantages, grafts prepared from extracted teeth have been described as an alternative to other bones. Both bone and tooth have a similar structure, as they originate from neural crest cells, and contain the same proportions of inorganic and organic components [18, 19]. The use of autogenous dentin graft has been investigated in a few studies with promising results. It might be regarded as a suitable substitute material to prevent the need for bone harvesting techniques. Wu D. et al [20] investigated the efficacy of autogenous dentin graft and xenogeneic bone graft in immediate implantation. They found that the two grafts had the same change in bone volume in the facial portion of the implant. Based on clinical evidence, they came to the conclusion that autogenous tooth bone derived from compromised teeth can be a suitable material for a bone graft based on clinical evidence.

This clinical study was performed to examine the validity of autogenous dentin graft in filling the jump gap associated with immediate implantation at the esthetic zone.

SUBJECTS AND METHODS

This randomized controlled clinical study was performed at the Oral and Maxillofacial Surgery Department, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University from December 2021 to October 2023. Patients with hopeless non restorable maxillary anterior teeth indicated for extraction and implant restoration were selected for the study. Patients were included in the study if they were having; non-restorable badly broken-down tooth / teeth in esthetic zone, intact socket wall after tooth extraction, and sufficient apical bone to allow adequate primary stability of the implant. Patients with acute infection or local pathological condition at the extraction socket, patients having any uncontrolled systemic disease, patients who have been treated with radiotherapy or chemotherapy to the head and neck area within the past 12 months and heavy smokers were excluded from the study.

Preoperative evaluation

Clinical evaluation of the patient including medical, dental history and a complete intra-oral

and extra-oral examination were carried out for each patient. The site of implantation was examined to assess the general oral hygiene, the tooth or root to be extracted, presence of infection, condition of the existing teeth, state of oral mucosa and the available inter arch space and occlusion. Radiographic evaluation included pre-operative exact height and width of alveolar ridge, bone density, and any pathologies that may involve the alveolar bone.

Exact bone height and width of alveolar ridge

The available bone were measured in mm using measuring tool (ruler tool) in blue sky bio software to detect bone defects and evaluate bone remodeling. From the alveolar crest to the closest anatomical landmark, the vertical bone height was measured while horizontal bone width was measured from the crest of buccal bone to the crest of palatal bone**.** Based on these dimensions, proper implant diameter and length were predetermined.

Bone density

Bone density around the offending teeth or roots were measured by Hounsfield units (HU). Using Blue Sky software and its integrated density measuring tool, the program automatically determined the HU. Using the density area tool, the bone density apical to the offending tooth was demarcated to detect the bone density of the bone and known the sequence of the drilling.

Patients who fulfilled the required inclusion and exclusion criteria (14 patients) were randomly divided into two equal groups (7 patients each). Group 1 of patients received immediate implant; the jumping gap was grafted with autogenous dentin graft .Group 2 of patients received immediate implant; the jumping gap was grafted with autogenous bone graft.

Ethical consideration

The treatment plan was discussed with the patients and the surgical procedure was explained using simple language, including the benefits and side effects, and including the possibility of intraoperative and postoperative complications. After obtaining verbal consent, the patients signed a special consent form. Following the Research Ethics Committee's ethical clearance No (783/ 4566), the clinical portion of the investigation was carried out at Faculty of Dental Medicine, Al-Azhar University.

Surgical procedures:

Patients of both groups received an oral hygiene protocol with scaling and root planning 2 weeks before surgery. They were advised to use 0.2% chlorhexidine mouth rinse (Hexitol mouth wash, the Arab drug Company) one week before surgery.

Extraction of the offending tooth:

Under local anesthesia, atraumatic extraction of the offending tooth was performed. Periotome (Periotome, Pakistan trade portal, Pakistan) was used for tearing of gingival and periodontal ligament fibers around the tooth for luxation. Forceps was used to extract the tooth out of its socket using gentle movements, care was taken to avoid any excessive pressure on the facial socket walls. Careful curettage of the extraction socket was carried out to remove any remaining periodontal ligaments, tooth fragments or debris. Then, the socket was copiously irrigated with normal saline, inspected, and explored with a blunt instrument to be sure that there was no bony defect.

Implant installation:

Using pilot drill, to ensure primary stability for the implant, under extensive saline irrigation, an osteotomy site was created in the apical third of the extracted tooth's socket, facing the palatal wall. It was extended 3 to 5 mm apical to the socket base. A paralleling pin was inserted into the initial osteotomy, then a periapical radiograph was taken for verification of the drilling location and angulation to the adjacent teeth. Sequential drilling was performed according to the manufacture

guidelines. After proper osteotomy preparation, the implant (Multysystem, Lissone (MB), Italy) was seated completely within the confine of the prepared socket in a vertical plane and screwed manually to reach the maximum manual torque then with ratchet wrench to seat the implant into its final position.

Immediately after insertion of the dental implant, a smart peg was attached to the implant fixture, and Ostell® device (Osstell device, Gothenburg, Sweden) was conducted to measure the primary stability PS of the implant in ISQs. The smart peg was removed, and the cover screw was adapted to the implant platform.

Filling of the jumping gap:

According to the planned grouping of patients, the jumping gap between the implant surface and labial cortex was filled with autogenous dentin graft in group 1, and autogenous bone graft in group 2.

Preparation of dentin graft:

It was a chair side process. The extracted tooth was examined for any restorations, caries, cementum, periodontal ligament, or pulp tissues. These, if present, were removed with a suitable size surgical bur. The cleaned remaining tooth part was drilled with rotary files to clean the root canals then was put in the grinding chamber of the Dentin Grinder (Smart Dentin Grinder, Komato, United Kingdom) for 3 seconds followed by vibration for 10 seconds to allow the particles within size of 300-1200 μm to pass through the sieve and keep the lager particles for further grinding.

Particles smaller than 300mm were disposed of in the waste chamber after passing through the lower sieve. For 10 minutes, the grinded particles were submerged in a dentin cleaner solution made of 0.5M NaOH and 30% alcohol (v/v) to dissolve all of the organic debris, bacteria and toxins present in the dentin particles. The processed graft was then ready for placement in the peri-implant gap **Figure 1**.

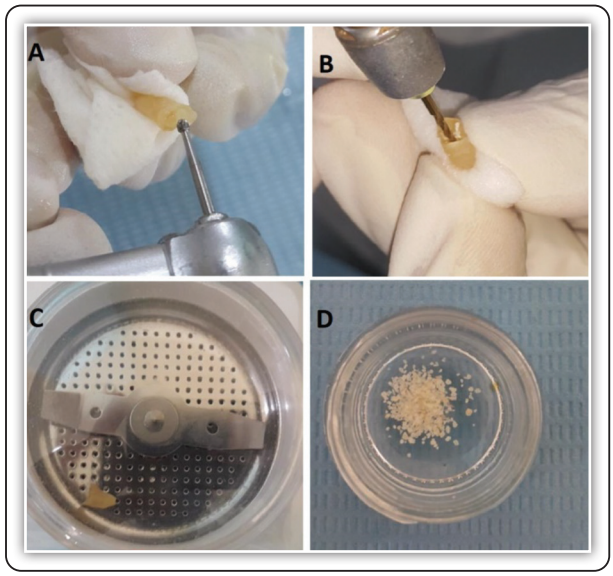

FIG (1) Dentin graft preparation; (A) Cleaning of the extracted tooth, (B) Root canal preparation, (C) Dentin grinder, and (D) Dentin graft prepared

After grafting the jumping gap with dentin graft the screw was removed, the healing abutment was placed, and the soft tissue closed with a single figure of 8 stitch using resorbable 4.0 suture material.

Procurement of autogenous bone graft:

Autogenous bone graft was harvested from the mandibular symphysis area. Under local anesthesia, a horizontal vestibular incision was placed below the mucogingival junction and a mucoperiosteal flap was reflected. Bone was harvested using a trephine bur size 5.0/6.0 mm. The trephine bur (trephine bur, Artistry Industry, Pakistan) was held perpendicular to the cortical plate keeping the cuts away from teeth roots, inferior border of the mandible and away from the mental foramen. The bone block was milled to granules using bone mill then it was mixed with saline and was immediately packed into the gap between the implant and the socket on the labial aspect.

Once the gap was filled with bone, an absorbable collagen cone (RESORBA® dental cones, iRES® SAGL, Switzerland) was placed in the donner site

to stabilize blood clots and prevent ingrowth of connective tissue. Then, the wound was closed in layers using 4.0 resorbable sutures **Figure 2**.

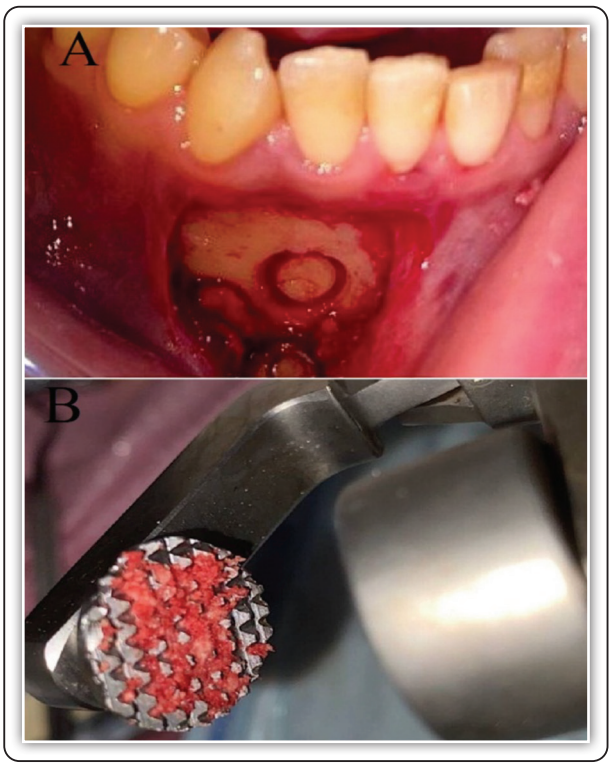

FIG (2) Autogenous bone graft harvesting; (A) Bone graft harvest from the mandibular symphysis, (B) grinding the collected block graft using a bone mill into small granules

After grafting the jumping gap with autogenous bone graft the screw was removed, the healing abutment was placed, and the soft tissue closed with a single figure of 8 stitch using resorbable 4.0 suture material.

Postoperative assessment

Implant stability

Using Osstell, the implant stability (ISQ) was measured in patients of both groups immediately and after six months following implant installation.

Bone density

Using CBCT, bone density was evaluated for all patients in both groups. Blue Sky Plan 4 software was used to measure changes in bone density immediately, three and six month following dental implantation.

Alveolar bone height

Using CBCT, alveolar bone height was evaluated for all patients in both groups. Blue Sky Plan 4 software was used to measure changes of alveolar bone height immediately, three and six month following dental implantation.

Statistical analysis

Data was fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Numbers and percentages were used to describe the qualitative data. The distribution's normality was confirmed using the Kolmogorov-Smirnov test. Quantitative data was described using mean and standard deviation. The significance of the obtained results was judged at the 5% level.

RESULTS

Clinical outcomes

Patients of both groups have completed the planned observation period. Postoperative healing was uneventful. Only, mild edema of the gingival tissue was seen on the first day after surgery. It subsided by the end of the fifth postoperative day. Neither postoperative infection nor dehiscence was recorded. No implant was lost from any patient of either group.

1. Gender and age distributions:

Fourteen patients (7 patients in each group) have completed the study. The male to female ratio in group 1, was 4:3 while in group 2, it was 3:4. There was no discernible statistical difference between the two groups. The mean age of group 1 was 35.28±4.78, while it was 37.71±4.38 in group 2. The difference between the two groups was statistically nonsignificant (Table 1).

TABLE (1) Gender and age distribution in both groups

		Group 1	Group 2	T	P
Gender	Female	3(42.9%)	4(57.1%)	X=.286[a]	0.593
	Male	4(57.1%)	3(42.9%)		
Age		35.28±4.78	37.71±4.38	-0.990	0.342

t: independent t test *X= chai square*

2. Implant stability:

All implants in both groups achieved primary stability and showed significant improvement in secondary stability measured 6 months after implant placement. The mean ISQ value significantly increased from 66.28±7.52 immediately after implant placement into 77.00±4.89 after 6 months in group 1. In group 2, it was significantly increased from 63.14±11.30 to 80.28±3.68. However, the difference between the two groups was nonsignificant (Table 2).

TABLE (2) Implant stability at different intervals between the two groups

Stability	Group 1	Group 2	P value
Immediate	66.28±7.52	63.14±11.30	0.552
6 months	77.00±4.89	80.28±3.68	0.182
P value	0.001*	0.003*	

Radiographic results:

Examination of CBCT showed that all implants in both groups were completely osseointegrated with no signs of bone defects or periimplantitis.

1. Bone density:

Table 3 shows the mean HU values of bone density at different time intervals in both groups. The mean HU value of bone density in patients of both groups increased significantly at 3 months and at 6 months in comparison to immediate mean HU value of bone density measured on CBCT. However, the difference between the two groups was nonsignificant at all intervals (Table 3).

2. Vertical bone height:

Table 4 shows the mean buccal vertical bone height values at different observation periods in both groups. The mean value of vertical bone height was reduced with time in both groups. The amount of buccal vertical bone height loss at 3 and 6 months was statistically significant in both groups. However, no difference was found between the two groups at all intervals (Table 4). As in group 1 the vertical bone loss was 0.35mm and 0.69mm at 3 months and 6 months respectively. While in group 2 was 0.42mm and 0.72mm at 3 months and 6 months respectively.

TABLE (3) Changes of the mean bone density values at different intervals

Bone density	Immediate	3 months	6 months	P value
Group 1	688.85±104.37	875.14±144.08	1163.85±230.20	≤0.001*
Group 2	720.57±143.91	937.28±93.91	1337.28±119.41	≤0.001*
P value	0.645	0.358	0,102	

TABLE (4) Changes with time of the mean buccal vertical bone height in both groups

Vertical bone height	Immediate	3 months	6 months	Total bone loss		P value
				3 months	6 months	
Group 1	1.34±0.38	0.99±0.32	0.65±0.33	0.35	0.69	0.006*
Group 2	1.47±0.18	1.05±0.14	0.75±0.10	0.42	0.72	≤0.001*
P value	**0.**441	0.676	0.436			

DISCUSSION

Immediate implant insertion is a widely recognized idea. In addition to shortening the amount of time needed for treatment, the process of immediate implantation in a newly created extraction socket may aid to preserve stable soft tissue and bone. As crestal bone loss is observed to be lower in implants placed immediately compared to implants placed later, there is no need to wait the 4-6 months after extraction for the bone to develop. Immediate implantation has a problem in primary stability due to the discrepancy in size and form between the extraction socket and the implant, there is usually a space left of the implant called jumping gap [10-15].

The jumping gap was tried to be filled with different graft materials with varying degrees of success. In the current study, in groups 1 and 2, the jumping gap was filled with autogenous dentin and autogenous bone grafts, respectively. Patients of both groups were evaluated for implant stability, the changes of bone density around implant, and the changes of vertical bone height.

During selection of the patients, care was taken to select patients with intact socket wall after tooth extraction to avoid labial bone fenestration. Fenestrated labial bone requires guided bone regeneration GBR procedure associated with flap elevation. This may result in bone resorption which conflicts with the most important point of the concept of immediate implant placement [21]. Also, In order to ensure sufficient primary stability of the implant, patients were selected with sufficient apical bone beyond the apex of the non-restorable tooth.

Individuals with acute infections were excluded due to the possibility of spreading the infection which may highly cause possibility of implant failure [22]. Patients treated with radiotherapy or chemotherapy to the head and neck area within the past 12 months were excluded as they may develop osteoradionecrosis or osteonecrosis of the jaw bones [23].

Regarding implant stability, it was checked twice, immediately after implant placement to measure primary stability PS (mechanical stability) and after 6 months postoperatively to measure secondary stability SS (biological stability). Primary stability was achieved by extending the osteotomies 3 mm beyond the apex of socket and by selecting width of implant that closely matches the width of extraction socket. The secondary stability was significantly increased when measured at 6 months after implant placement in both groups. Secondary stability is affected by the quality and quantity of bone at the bone-implant interface [24]. The increase of ISQ values in secondary stability is considered an indication of an osseointegration process at the implant-bone interface. The formation of a new bone around the implant surface together with the graft filling the jumping gap produced direct structural and functional connection with the surface of the implant [25]. There was insignificant difference between both groups regarding secondary stability.

These results were in agreement with the studies performed by Eun-Seok K et al[26] , Adam S. et al[27] and Korsch M[28] as they found increase in the stability of dental implants and attributed this to osseointegration around dental implants.

Bone density reflects the bone quality and affects the initial stability and survival rate of the implants. Radiographic images of CBCT were used to evaluate alveolar bone density. Razi et al [29] found a strong correlation between HU in CT scans and the voxel gray scale in CBCT and suggested that the voxel value in CBCT can be used for the estimation of bone density. By the end of the 6th month after implant placement, the bone density at the graft site was markedly improved. After implant insertion, both groups' mean bone density values increased significantly at 3 and 6 months. This might be attributed to the new bone formation, mineralization, and remodeling of the grafted jumping gaps.

A reliable source of BMPs, bioactive growth factors (GFs), and transforming growth factor-B (TGF-B) is a dentin graft. Due to its rich contents of bone morphogenetic protein and growth factors, dentin could promote bone marrow mesenchymal stem cell differentiation and accelerating osteogenesis which all play a role in bone repair processes [30].

However, no difference was found between either group. This might be explained by the close similarity between alveolar bone graft and dentin graft. Teeth, particularly dentin have a chemical composition that is extremely similar to that of bone. The improvement of bone density in the current study is in accordance with the results of El-Ghaysh et al [31] and El-Said et al [32]. They attributed the increases in bone density to the formation of new bone within the graft particles and the slow resorption rate of the graft.

The level of the facial marginal bone is crucial for the facial gingiva of an implant and played an important role for the implant's long-term success. Results of this study revealed that the mean value of vertical bone height was reduced with time in either group. Both groups showed minimal statistically non-significant resorption rate. The vertical bone loss was 0.33mm and 0.69mm at 3 months and 6 months respectively in group 1. While in group 2 it was 0.42mm and 0.72mm at 3 months and 6 months respectively.

This denotes that the alveolar bone level and the gingival level were stable in the two graft materials. Filling the jumping space with either grafting material could serve to avoid severe resorption of the thin labial bone plate, promotes new bone formation, and enhances the level of bone-to-implant contact. This is clinically acceptable and coincidental with Gabr et al [33] who compared autogenous dentin graft versus a combination of autogenous dentin graft and PRF placed in jumping space in esthetic zone.

CONCLUSIONS

Within the limitations of the present study, it could be concluded that:

1. The use of either autogenous dentin graft or autogenous bone graft to fill the jumping gap in immediate implant placement in the maxillary esthetic zone achieved acceptable clinical and esthetic outcomes.
2. Autogenous dentin is an acceptable graft material that can be used safely to fill the jumping gap in immediate implant placement in the maxillary esthetic zone.
3. The use of autogenous dentin graft processed from the patient's extracted tooth avoids the donor site morbidity associated with autogenous bone graft.

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