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The Impact of Using Nano zeolite around Immediate Dental Implant. (A Novel Clinical Study)

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Abstract

Purpose: The present study was designed to evaluate the clinical, radiographic and biochemical efficacy of nano zeolite with immediate dental implant.

Patients and Methods: In this study a single immediate implant at a maxillary anterior teeth were performed on 30 patients who were divided randomely into two equal groups Group I: Patients received immediate dental implant alone. Group II: Patients received immediate dental implant with locally applied Nano zeolite. Clinical and radiographic parameters were recorded for all implants at baseline, 6 and 12 months. Moreover, Implant stability was assessed immediately after implant insertion and six months post-operatively. Biochemical analysis for RANKL levels in periimplant crevicular fluid were assessed at baseline, 4 weeks and 3 months.

Results: Regarding clinical parameters, modified plaque index (mPI), modified sulcular bleeding index (mBI) and peri implant probing depth (PPD), no statistically significant difference was found between both groups at the different intervals. While implant stability showed statistically significant difference to group II in relation to group I at 6 months. Regarding marginal bone loss (MBL) and bone density, statistically significant differences to group II in relation to group I were found at 6 and 12 months. Regarding biochemical analysis for RANKL levels, no statistically significant difference was found between both groups at different intervals.

Conclusions: Nano zeolite showed promising clinical and radiographic results and can be used as a new effective bone graft material around immediate dental implant.

I. Introduction

Immediate dental implant placement in fresh extraction sockets was introduced in order to reduce the number of surgical procedures and potentially limit physiological bone resorption [(1)].

However, immediate implant placement may not always provide successful clinical outcomes [(2,3)] and has been documented that this surgical protocol fails to prevent the horizontal and vertical ridge alterations[(4)]. This may result in impaired esthetics such as marginal soft tissues recessions, especially if treating the buccal side of maxillary sites in patients with a high smile line [(5,6)].

The use of biocompatible implant material and stress free healing period before loading and sterile condition are recommended to ensure durable osseointegration of dental implants**.** In order to improve the aesthetic

outcomes and reduce the bone dimensional changes several techniques have been proposed, such as flapless protocols, imediate provisionalization**,** connective tissue grafting and guided bone regeneration (GBR) techniques [(7)].

The use of (GBR) technique is an important step to fill a gap between the dental implant and bone walls. A variety of surgical procedures have been utilized to improve the bone thickness and osseointegration for the placement of implants involving various grafting material techniques[(7)].

Nano zeolite based materials can be considered as a kind of bioactive ceramics, and thus they can be used effectively in the construction of scaffolds for bone tissue engineering, in which zeolites can mimic the mineral component of the natural bone matrix and also promoted the proliferation of human fibroblasts and mesenchymal
stem cells, and the differentiation of MSCs towards osteoblasts. In addition, these materials did not evoke any inflammatory reaction after implantation[(8,9)].

Other important zeolite-containing biomaterials are zeolite /chitosan hybrid composites with zeolite contents of 20–55wt%, These composites contained macro pores ranging in size from 100μm to 300μm, and showed suitable mechanical properties for bone tissue engineering. In addition, when immersed in simulated body fluid, they acted as bioactive,i.e. they promoted the formation of hydroxyapatite (HAp) by their ion exchanging properties and when enriched with silver, they showed antimicrobial activity [(10)].

Zeolites also enhanced the growth and osteogenic differentiation of osteoblasts, when added directly to cell culture media. Specifically, synthetic Na-A zeolite added into a cell culture medium enhanced the autocrine synthesis of transforming growth factor-β, DNA synthesis, the activity of alkaline phosphatase and the production of osteocalcin in normal human osteoblast-like cells, zeolite A also inhibited osteoclast-mediated bone resorption in vitro[(11)].

RANKL is a member of the tumor necrosis factor cytokine family, it binds to RANK on cells of the myeloid lineage and functions as a key factor for osteoclast differentiation and activation. RANKL may also bind to osteoprotegerin, a protein secreted mainly by cells of the osteoblast lineage which is a potent inhibitor of osteoclast formation by preventing binding of RANKL to RANK [(11,12)].

II. Aim of the study

The purpose of the study was to evaluate the clinical, radiographic and biochemical efficacy of nano zeolite with immediate dental implant .

III. Patients and methods

This study was designed as arandomized clinical controlled study carried on 30 patients selected from the outpatient clinics Department of Oral Medicine and Periodontology, Faculty of Dentistry Al-Azhar University, Assiut branch seeking immediate dental implant.

Inclusion and exclusion criteria**:**

Patients selected had hopless tooth (badly decayed, endodontic failure, root fracture,root resorption or periodontally affected tooth). All patients were medically free according to Cornell Medical Index [(13)] and should have not any known contraindication to surgery.

The research protocol will be approved by the ethical committee, Faculties of Dental Medicine, AL-Azhar University and enrolled patients sing a written consent form.

Patients were divided randomely by acoin into two groups:
Group I: 15 Patients received immediate dental implant alone.

Group II: 15 Patients received immediate dental implant with locally applied Nanozeolite.

All patients were subjected to phase I periodontal therapy prior implant placement to provide an oral environment more favorable to wound healing.

Pre operative cone beam computed tomography and periapical radiographs were done to all patients for implant implant selection and assessment of (MBL and bone density).

IV. Surgical Procedures

The pre-operative classification proposed by Salama and Salama[14] was used to categorize the cases and only type I extraction sites were selected. The surgical site was locally anesthetized. Sulcular incision was created for the implant site, using 15 Bard Parker blade. The tooth was extracted carefully with minimal trauma either to the bone or soft tissue. Initiation of the osteotomy was performed 3 mm beyond the extracted root apex and along the palatal wall to ensure that buccal aspect of the implant doesn't rested against the buccal plate to avoid necrosis or perforation. The selected dental implant was placed within the body of the alveolus and torque wrench was used to obtain good primary stability. The implant head were positioned maximally 3mm below the CEJ of the adjacent teeth and above the alveolar bone crest to assure proper implant emergence profile and facilitate proper implant restoration.

In group II, Nano zeolite was mixed with sterile saline solution; then applied to fill the space between implant and socket wall. The smart peg was screwed to the implant fixture the primary implant stability quotient (ISQ) was measured. Healing abutment was positioned to enable the clinical and biochemical evaluation during the observationa periods of the study. The final wound closure was performed by interrupted 0/4 non resorbable sutures. After 6 months, definitive abutments were tightened and final porcelain prostheses were cemented.

V. Periodontal Evaluation:

The following clinical parameters were recorded for all implants at baseline, 6 and 12 months.

A-Modified Plaque Index (mPI) [15]

B-Modified Bleeding Index (mBI) [15]

C-Peri-Implant Probing depth (PPD) [16]

Implant Stability The primary stability was recorded after implant surgery using Osstell[5]. The stability was measured in triplicate and averaged to yield the mean baseline for each implant. A secondary stability measurement was taken at 6 months

Radiographic Evaluation:

The following parameters were recorded for all implants at baseline, 6 and 12 months by CBCT and periapical radiographs.

A- Marginal bone Level

B- Bone Density.

Biochemical assessment

RANKL level in periimplant GCF were assessed in baseline, 4 weeks and 3 months. GCF samples were obtained from the site of implant[17]. Before sampling, the selected teeth were isolated with cotton rolls and supra-gingival plaque was removed without touching the marginal gingiva.

The implant site was then dried gently with an air syringe. Samples of GCF were obtained before probing into the site by placing paper point. Sterilized paper point size #30 was carefully inserted into the implant site and held in position for 30 seconds**.** The collected GCF was immediately transferred to an Eppendorf tube size 1.5 ml containing 1 ml of phosphate buffer solution and transported to the laboratory.

Statistical analysis.

The data were collected, tabulated and statistically analyzed using IBM SPSS Statistics Version 20 for Windows.

a

b

VI. Results:

Clinical Results

Paired t-test showing statistical significant changes observed at different intervals when compared to the baseline in both groups.

Unpaired t-test for comparing the two groups showing no statistical significant changes observed between both groups at different intervals.

Implant Staility:

Paired t-test showing Statistical significant difference at 6 months when compared to baseline in both groups.

Unpaired t-test for comparing the two groups showing Significant difference to group II in relation to group I was found at 6 months.

MBL and Bone Density:

Paired t-test showing Statistical significant difference at different intervals when compared to baseline in both groups.

Unpaired t-test for comparing the two groups showing Significant difference to group II in relation to group I was found at 6 and 12 months..

Biochemical analysis for RANKL levels **Paired t-test** showing Statistical significant difference at different intervals when compared to baseline in both groups.

Unpaired t-test for comparing the two groups showing no significant difference between the two groups at different intervals.

c

e

d

f

Table (1) Showing clinical, radiographic and biochemical results of the studied groups at different intervals including means ± standard deviation , and P values within and between the groups.

Figure 1 a-f: Clinical photographs of group II patient Showing :
(a) A male patient of 25 years old with root fractured upper central incisor.
(b) Dental implant insertion (c) Implant inside socket
(d) Periimplant space filled with Nanozeolite.
(e) Healing abutment placement (f) Final restoration placement 6 months later

		Clinical parameters														
Varialble		**Peri-implant depth**			*P value*		**Modified plaque index**			*P value*		**Modified bleeding index**			*P value*	
		Baseline	6m	12m	Baseline VS 6 m	Baseline VS 12m	Baseline	6m	12m	Baseline VS 6m	Baseline VS 12 m	Baseline	6m	12m	Baseline VS6 m	Baseline VS12 m
G I		3.35±0.6	2.55±0.49	2.53±0.35	**0.001***	**0.003***	0.13±0.16	0.39±0.1	0.53±0.1	**0.002***	**0.000***	0.18±0.12	0.43±0.1	0.51±0.17	**0.002***	**0.001***
G II		3.3±0.5	2.45±0.49	2.35±0.31	**0.001***	**0.000***	0.08±0.0	0.38±0.1	0.53±0.17	**0.000***	**0.000***	0.12±0.11	0.47±0.1	0.60±0.1	**0.000***	**0.000***
P value	**GI VS GII**	**0.712**	**0.891**	**0.398**			**0.670**	**0.997**	1.**000**			**0.553**	0.**795**	**0.348**		

		Implant Stability			**Biochemical Results**					**Radiographic Results**								
Variable		**Basline**	6m	*P value*	**RANKL level**			*P value*		**Marginal bone loss**			*P value*		**Bone density**			*P value*	
				Baseline VS 6m	Baseline	4 week	3m	Baseline VS 4w	Baseline VS 3m	Baseline	6m	12m	Baseline VS 6 m	Baseline VS 12m	Baseline	6m	12m	Baseline VS 6 m	Baseline VS 12m
G I		64.±5.7	70±41	**0.000***	0.94±0.18	0.89±0.23	0.72±03	**0.000***	**0.00***	0±0	0.56±03	0.97±0.13	**0.000***	**0.000***	79±5.5	93±5.2	106±6	**0.000***	**0.000***
G II		62±5.69	75±73	**0.000***	1.07±0.32	0.86±0.21	0.72±08	**0.000***	**0.00***	0±0	0.42±05	0.68±0.06	**0.000***	**0.000***	82.5±65	107±7.3	127±7	**0.000***	**0.000***
P value	**GI VS G II**	**0.580**	**0.032***		**0.529**	**0.971**	**1.000**			**0.835**	**0.008***	**0.000***			**0.935**	**0.000***	**0.000***		

VII. DISCUSSION

Immediate dental implants have several advantages since; the total treatment time and number of surgical procedures is reduced, in addition; the soft tissue height and contour are better preserved in comparison with other protocols[18]. More recently, tissue engeneering is very much considered in various medical fields, as well as in the soft and hard tissue engineering of the oral cavity[19].

Zeolite is one of the materials used as ascaffold in bone tissue engeneering due to its chemical and porous structure and the possibility of implantation of cells in these pores. Zeolites also enhanced the growth and osteogenic differentiation of osteoblasts when added directly to cell culture media [8].

So, the purpose of this study was to evaluate the clinical, radiographic and biochemical efficacy of nano zeolite with immediate dental implant.

As regarded to selected sites the present research was performed on four osseous walls remaining. Type I classification with the presence of three to four remaining osseous walls is essential to immediate implant success and that implant failure rates significantly increase when this principle is violated [14].

Atraumatic extraction technique was used in the present research, this is very important for the success of implants and facilitates maintenance of the maximum amount of bone[20] .

To achieve sufficient primary stability, the osteotomy preparation in all cases extended 3 to 5 millimeters beyond the base of the socket [21].

Healing period in this study relapsed about 6 months. This according to a study concluded that the healing period is about 6 months for immediate placement in maxillary region [22].

The diagnostic imaging of implant site is an essential and integral component of the implant treatment planning. Cone beam CT scan is well suited for imaging the preoperative implant site. It provides clear images of highly contrasted structures and is extremely useful for evaluating bone. The present study used both intraoral paralling periapical radiographs in addition to CBCT to ensure adequate evaluation to implant site[23,24].

RANKL is essential for the complete differentiation of osteoclast precursor cells and plays a critical role in periodontal bone resorption. The level of RANKL mRNA has been reported to be highest with bone destruction in advanced periodontitis and decreased with bone formation after periodontal treatment or in healthy group [25,26], so the present study used GCF level of RANKL as an indicator to the process of bone regeneration.

As regard to the follow up period in the present study extended to 12 months postoperatively as most implant complications and failures are most likely to occur in the first year of placement of dental implant, this in agreement with a study concluded complete implant failure ranging from 3% to 8% after an implant has been restored and placed in function for the first year [27].

During of the evaluation period, patients showed generally good oral hygiene+e habits and very good soft tissue around the implants. In accordance the results of the present study showed a significant difference in both modified plaque and gingival indecies after 6 and 12 months when compared to baseline in the two groups which may be due to the decrease of patients cooperation and motivation during the observation period of the study[28].

Implant stability quotient was performed in the present study by Osstell depends on resonance frequency analysis which recorded in hertz and converted to (ISQ) [29] Primary stability appeared nearly similar in two groups, while the secondary stability appeared superior in group II in relation to group I. All cases of the present work showed a good secondary implant stability these means direct connection between living bone and the surface of implant i.e. excellent osseointegration[30].

Peri-implant probing depth in the present study was showed no statistical significant difference observed between the two groups. These findings reflects the good healing environment of the soft tissue around the implant particularly in group II.

As regard to the changes in marginal bone loss, The findings of the present work showed increase in the mean value of bone loss in different groups at 6 and 12 months when compared to baseline, these findings could be attributed to implant loading that performed after 6 months of the study [31].

There was statistically significant difference in marginal bone loss and bone density between group II when compared to group I at 6 and 12 months, this may be attributed to the efficacy of NZ in group II. These results agree with a study concluded that bone loss of more than 2 mm at 12 months following immediate implantation was considered a negative effect on osseointegration of dental implant and indicate implant failure [(32)].

Biochemical parameters within the peri-implant crevicular fluid provide information about the environment around dental implants, thereby helping to monitor the health and disease state of surrounding tissues. The results of the present study showed significant difference in the level of RANKL after 4 weeks and 3 months when compared to baseline in the two groups .These findings reflects the active process of bone regeneration and this is in a agreement with a study claimed that the level of RANKL has been reported to be highest with bone destruction in advanced periodontitis and decreased with bone formation after periodontal treatment[(17)].and no statistical significant difference between different groups after 3 months which reflect the maturity of bone at this stage.

VIII. Conclusions

Immediate dental implant placement with Nano zeolite appeared significantly superior to dental implant alone on the level of clinical and radiographic parameters, So it could be successfully applicable for the treatment of bony defects around an immediate dental implant.

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