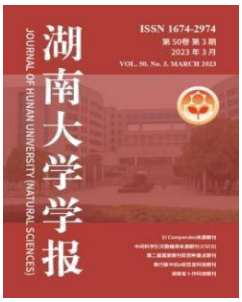

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Evaluation of Efficiency of Ozone Gel on Bone Healingaround Immediate Dental Implants (Clinical and Radiographic Study)

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Abstract (in English): Objectives: This study was designed to evaluate the effect of using bone graft alone versus bone graft mixed with ozone gel with immediate dental implant placement. **Subjects and methods**: eighteen patients selected from those attending the outpatient clinic of Oral and Maxillofacial Department, Faculty of Dental Medicine, Al-Azhar University, Assiut branch had isolated hopeless tooth in need for extraction and indicated for immediate dental implant placement. Patients were classified randomly into the following two groups: Group I: Patients were treated by immediate implant combined with Nano tricalcium phosphate alone. Group II: Patients were treated by immediate implant combined with Nano tricalcium with topically applied ozone gel. Stability, bone density and marginal bone level were assessed. **Results**: Implant stability group (II) (study group) showing increase in ISQ with statistically significant differences when compared to group(I) (control group). Marginal bone loss: the group (II) (study group) showing decrease in marginal bone loss with statistically significant difference when compared with group(I) (control group) at 9 months. Bone density: The present study showing non- statistically significant differences when compared to group(I) (control group) with group (II) (study group). **Conclusion**: The use of ozone gel at the time of implant placement can be considered an effective adjunctive that improves the implant stability and decreases marginal bone loss. The use of ozone gel combined with bone graft shows non- statistically significant bone density around dental implant.

Keywords (in English): Ozone, Immediate implant, Implant Stability, Marginal bone loss and Nano tricalcium phosphate.

Introduction

One of the advantages of placing dental implants immediately after tooth extraction is that it reduces the number of surgeries and prevents excessive bone loss [(1)]. However, this approach may not always achieve optimal clinical outcomes, such as preserving the ridge dimensions and avoiding soft tissue recession that may compromise the esthetic appearance [(2)]. Several techniques have been suggested to improve the esthetic results and minimize the bone changes, such as avoiding flap elevation, providing immediate provisionalization, using connective tissue grafts, applying Guided Bone Regeneration (GBR) methods orfilling the gap with a bone substitute material [(3)]. Various types of bone grafts have been used to treat bone defects around dental implants, such asautografts, allografts, xenografts and synthetic materials. Beta tricalcium phosphate/collagen β- TCP/col is a material that is biocompatible and bioresorbable and has similar properties to the mineral phase of bone, leading to the formation of new bone around the dental implant [(4)]. Another potential way to enhance the bone healing process around the dental implant is the use of ozone therapy. Ozone therapy is a bio-oxidative therapy that uses oxygen/ozone in different forms to obtain therapeutic benefits [(5)]. Ozone is produced by splitting the oxygen molecule into two reactive oxygen atoms that combine with another oxygen molecule.

Ozone increases tissue oxygenation, it kills bacteria, fungi, and viruses, it stimulates the immune system to produce cytokines, interleukin 2, and interferon, and it enhances cellular energy by activating the Krebs cycle to produce adenosine triphosphate [ATP] [(6)]. Moreover, ozone can stimulate cell growth and accelerate soft tissue healing, which was demonstrated by positive results in preventing and treating bone necrosis and post-extraction woundhealing and showed good results in treating resistant osteomyelitis in the head and neck as an adjunctive therapy with antibiotics, surgery, and hyperbaric oxygen therapy [(7)]. When Ozone therapy is applied to implants, it may have antimicrobial properties and promote bone and periodontal cells regeneration like that around natural tooth, it may also affect bone density and quality of dental implant osseointegration [(8)].

1. Subjects and methods

This study was designed as a randomized controlled clinical trial carried out on 18 male's patients ranged in age from 23-50 years. All patients were selected from those attending at the Outpatient's clinic of Oral and Maxillofacial surgery Department, Faculty of Dental Medicine Al-Azhar University, Assiut Branch. All selected patients had hopeless teeth (with endodontic failure, root fracture, external/internal root resorption, decayed non-restorable tooth or retained deciduous tooth) assessed by clinical and radiographic examination, in need for extraction and indicated for immediate dental implant placement.

2. Ethical approval:

The study protocol was approved by the ethical committee AUAREC202300010-2, Faculty of Dental Medicine, Al-Azhar University, Assiut Branch. All patients were thoroughly informed of the nature, potential risks and benefits of their participation in this study and signed their informed consent documents.

3. Inclusion criteria and Exclusion criteria:

1. Patients were physically and psychologically able to sustain conventional surgical and restorative procedures and patients should be free from any systemic condition that might alter the predicted outcomes.

2. Patients were cooperative, motivated, and had good oral hygiene.

3. The implant sites had opposing natural teeth, not drifted, malposed or over erupted to the implant site.

4. The implant sites had adequate bone quantity (width & height) and suitable bone quality.

5. Acute infected socket and any socket with wall defect.

6. Patients had para functional habits such as bruxism and clenching.

7. Heavy smokers' patients, alcohol or drug abused patient.

4. Sample size calculation and power analysis:

For the sample size calculation, the power analysis was performed using G power system for a one_ way fixed effects analysis of variance (ANOVA). The criterion for significance was set at A= 0.005 (Type1 error) and B =0.20 (type II error). The sample size was determined as 9 cases per group.

5. Patient grouping and randomization:

Patients were classified randomly into the following equal two groups by flip coin. Group 1:

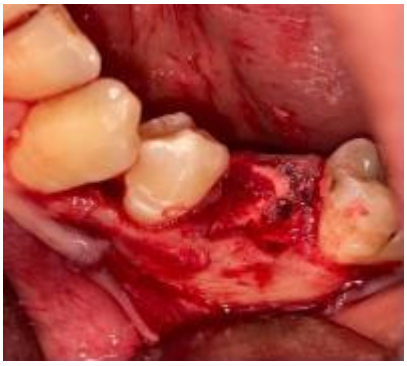
Included 9 patients were treated with immediateimplant combined with Nano tricalcium phosphate as a bone graft. Group 2: Included 9 patients were treated with immediate implant combined with Nano tri calcium phosphate mixed with applied ozonegel*.

6. Surgical Procedures (figure (1,2):

Before surgery, all patients were rinsed with 20 ml chlorhexidine gluconate 0.12% solution (hexitol) ®*for 30 second as a topical antimicrobial agent. A surgical site was locally anaesthetized by Artinibsa ® 40mg/0.01 mg/ml (Articaine hydrochloride+ Epinephrine(adrenaline)). A 15 blade was used to make an intrasulcular incisions to raise a full thickness flap which elevated and extended under the anticipated apical extension of the preplanned implant length. This method allows exact evaluation of buccal wall integrity of the tooth to be extracted. A traumatic tooth extraction was done by using elevators to avoid any trauma during extraction and forceps of anatomic design that rotate the root in a clockwise- counterclockwise fashion to retrieve the root from the alveolus. After extraction, socket was degranulated with curettes to remove all remnants of the periodontal ligament and granulation tissue. The drilling of implantwas done in sequential manner. The implant was removed out of its vial and inserted about 2mm apically to the extracted tooth according to determined length and width according to the analysis of each case that done by cone beam computed tomography. Ratchet was used to insert the implant and tight in its site in a clockwise direction. Smart peg was applied to implant fixture for determination and reading the primary stability with implant stability quotient (ISQ) ostell.The cover screw was removed from the bottom of the implant vial by a hex tool and screwed into the implant body. In group I Nano tricalcium phosphate was applied around dental implant as a graft material. In group II Nano tricalcium phosphate with ozone gel wasapplied around dental implant as a graft material. The buccal and the lingual soft tissue were approximated and sutured by interrupted suture by resorbable sutures (vicarial 3.0).

Sutures were removed after 14 days postoperative. All patients were instructed to avoid the use of the surgical site for 6 weeks. After 6 months the second stage exposure of implant, measure the secondary stability and healing abutment was applied about 3 weeks. After 3weeks the healing abutment was removed and permanent abutment was applied. The final porcelain fused to metal prosthesis wasmanufactured, then cemented in its place.

Figure (1): Clinical socket degranulation, implant drilling and placement , Smart peg and ostell.



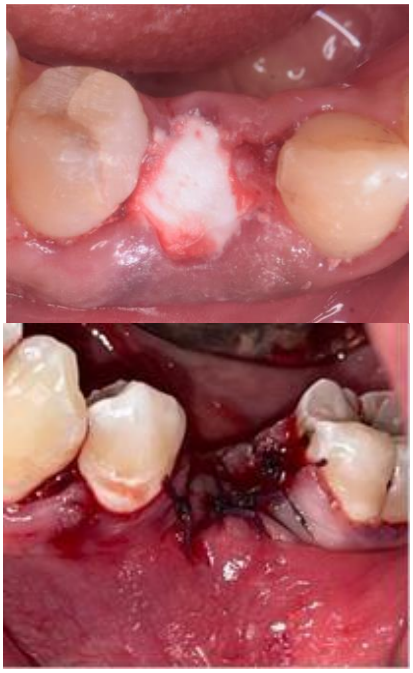


Figure (2): Bone graft without ozone gel, bone graft with ozone, suturing.

7. Evaluation:

7.1. Implant stability:

All implants were estimated for primary stability once after implant insertion with an Osstell®1 Mentor magnetic resonance device that uses resonance frequency analysis for determining implant stability. Additional resonance frequency analysis (RFA) was taken at the 6 months follow-up to evaluate the secondary stability.

Measuring of marginal bone level: Marginal bone level around the implant was evaluated using: Periapical Paralling technique that were taken on the day of the implant placement (baseline), and on the following-up visit at 3,6 and 9 months. The distance from a reference point at the implant to the most coronal point where the marginal bone contacts the implant was measured in millimeters. Measurements were made mesially and distally in each implant and the mean MBL was calculated.

7.2. Measuring of bone density:

Bone density around the implant was evaluated using: CBCT that were taken pre-operatively, immediately, and at 3 & 6 months ,9months postoperatively, to assess bone density around dental implants. Measuring was done with Hounsfield units (HU) at six points aligned immediately labial or buccal to the placed implant using the imaging software.

8. Statistical analysis:

The mean and standard deviation values were calculated for each group in each test. Data were explored for normality using Kolmogorov- Smirnov and Shapiro-Wilk tests, data showed non-parametric(not normal) distribution. Mann-Whitney was used to compare between two groups in non-related samples. Wilcoxon was used to compare between two groups in related samples. Spearman correlation was used to find the correlation between different parameters and the significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

9. RESULTS

9.1. Implant stability:

There was no statistically significant difference at (baseline) between (Group I) and (Group II) where (p=0.860). - There was a statistically significant difference at (6m) between (Group I) and (Group II) where (p=0.024). Group II showed a statistically significant higher Implant stability than Group I.

9.2. Marginal bone loss:

There was no statistically significant difference at (baseline), (3m) and (6m) between (Group I) and (Group II) where (p=1), (p=0.462) and (p=0.512) respectively. - There was a statistically significant difference at (9m) between (Group I) and (Group II) where (p=0.041). Group II showed a statistically significant lower Marginal bone loss than Group I.

9.3. Bone density:

There was no statistically significant difference at (baseline), (3m), (6m) and(9m) between (Group I) And (Group II) where (p=0.516), (0.477), (0.727) and (0.057) respectively. Bone density showed no statistically significant in both Groups.

[1] Osstell; Integration Diagnostics Ltd., Göteborg, Sweden

Table (1): The mean, standard deviation (SD) and p-values of both groups.

	Group I		Group II		p-value
Implant stability	Mean	SD	Mean	SD	
Baseline	70.71 Ba	2.97	71.57 bA	3.72	0.860ns
After 6m	76.57 aB	2.58	85.71 aA	2.43	0.024*
	<0.001*		<0.001*		
Marginal bone loss					
Baseline	0.00 dA	0.00	0.00 dA	0.00	1ns
After 3m	0.33 cA	0.11	0.23 cA	0.07	0.462ns
After 6m	0.54 bA	0.10	0.46 bA	0.08	0.512ns
After 9m	0.93 aA	0.06	0.77 aA	0.06	0.041 *
	<0.001*		<0.001*		
Bone density					
Baseline	615.00 bA	48.65	568.57 cA	49.49	0.516ns
After 3m	645.86 aA	56.06	589.86 bA	51.62	0.477ns
After 6m	667.14 aA	62.55	637.43 aA	54.65	0.727ns
After 9m	707.29 aA	64.90	636.43 aA	53.80	0.057
	0.026*		<0.001*		

Means with different small letters in the same column indicates significant difference, means with different capital letters in the same row indicates significant difference. *; significant (p<0.05) ns; non-significant (p>0.05)

10. DISCUSSION

The aim of the present study is to compare clinically and radiographically between: Immediate dental implant with bone graft alone versus immediate implant with bone graft mixed with ozone gel in followup period up to 9 months. Bone graft was used to fill the space surrounding the implants. Nano tri calcium phosphate as a synthetic material is particularly attractive due to the absence of disease transmissionrisk and reproducibility of their chemical composition and porous architecture [9,10].

One of the benefits of inserting implant right after tooth removal is that it allows direct contact between the bone and the implant in the apical area, whichimproves the apical bone support and results in a high level of initial mechanical stability. To achieve adequate initial primary stability, the bone height of thesockets (from the apex of the alveolus to the crest of alveolar bone) should be at least 7- 10 mm [11]. Therefore, the minimum vertical bone height selectedin this study was more than 10 mm and to obtain adequate primary stability, the bone preparation extended 2 to 3 millimeters beyond the base of the socket [12]. During the early stages of osseointegration, immature bone is quickly formed in the gap between the implant and the bone; it grows fast, up to 100 μm per day in all directions. It has a random orientation of its collagen fibrils, high cellularity, and low degree of mineralization, which makes its biomechanical capacity poor. Therefore, any occlusal load should be well controlled or avoided in the early phase of healing to prevent high-risk for fibrous encapsulation of the bone defect, lack of osseointegration, apical epithelial migration on to the implant surface and lack of primarybone contact [13]. All cases in this study followed a delayed occlusal loading protocol. The mean value of primary implant stability quotient (ISQ) was 70 ISQ forgroup 1 and 71 ISQ for group 2. The primary stability of implant with ISQ more than 60 is considered to be suitable [14]. In addition, the secondary stability in this study increased over time. The mean of secondary implant stability quotient (ISQ) was 76ISQ for group I and 85 ISQ for group II. It was reported that secondary stability becomes evident only as new bone forms around the implant, ISQ values increased significantly over time and towards the sixth month [14]. The present study showed a statistically significant difference atsecondary stability at ozonated group compared to control group where p=0.024. This improvement may be attributed to ozone therapy which has positive effects on oxygen metabolism, cell energy, immune system, antioxidant defense system, and microcirculation, that lead to improvement of bone formation around implant [15].

A better tissue healing profile of ozone in present study could be attributable to the super active oxygen, which, by reacting with blood components generates a number of chemical messengers responsible for activating crucial biological functions such as oxygen delivery, immune activation, release of hormones and induction of antioxidant enzymes, which may mobilize endogenous stem cells, which will promote regeneration of tissues [16].

For marginal bone loss, the accepted guidelines for implant induced bone loss are less than 1.5 mm for the first year after implant loading and less than 0.2 mm for each additional year [17]. The means of marginal bone loss recorded in both groups in the present study were within the accepted limits occurring with adequate osseointegration which did not exceed 1mm.It may be due to proper patient and implant selection, proper surgical protocol and adequate loading of the implant prosthesis in proper time and with suggested manner [18,19].

The present study showed statistically significant differences in marginal bone loss (MBL) to control group at 9month when compared to ozonated group where p=0.041. The improved marginal bone preservation in ozonated group may be referred to activation of osteoblasts, osteosynthesis and decrease in osteoclastic activity. Under the influence of ozone therapy, ozone leads to a higher expression of cytokines especially Transforming Growth Factor TGF- β1 [20] which has the ability for regulation the initial wound healing phase. TGF-β1 also, has an obviouseffect on cell proliferation (monocytes and fibroblasts),angiogenesis, synthesis of collagen and extracellularmatrix [21].

Regarding bone density around dental implant, there were no statistically significant differences at the different intervals. The present study disagrees with different previous studies, they concluded that a significant increase in bone density for both groups during follow up intervals. May be not agree with different studies due to different in initial bone density between two groups where control group bone density high value when compare with study group and may be due to method of uses ozone gel lead to increase in bone density in ozonated group in some studies due to ozone therapy improved the local environment in the peri-implant interface zone by its bactericidal activity, enhancing local oxygen supply and promoting hemostasis, which may leads to enhancement of the proliferation of osteoblasts, therefore increasing the rate and amount of bone formation and mineralization on the peri implant bone interface [22,23] .

The success of an implant depends on the direct contact of implants with the bone tissue, which is called osseointegration. Osseointegration is a complex process that is influenced by immune and inflammatory responses [24]. Besides the interaction of implant with the bone tissue, the interaction of implant withperiodontal tissue is also very important. Ozone helpsin preventing infection and enhancing bone formation, which helps in dental implant osseointegration [25, 26].

11. Conclusion

The use of ozone gel at the time of implant placement can be considered an effective adjunctive that improves the implant stability and decreases marginal bone loss. The use of ozone gel combined with bone graft shows non- statistically significant bone density around dental implant.

References

1. TONETTI, M. S., CORTELLINI, P., GRAZIANI, F. Immediate versus delayed implant placement after anterior single tooth extraction: the timing randomized controlled clinical trial. J Clin Periodontal. 2017; 44, 215–224.
2. TADIC D, EPPLE M. A thorough physicochemical characterization of 14 calcium phosphate-based bone substitution materials in comparison to natural bone. Biomaterials. 2004; 25: (6):987–94
3. CHEN S. T, BUSER D. Esthetic outcomes following immediate and early implant placement in the anterior maxilla – a systematic review. The Int J of Oral & Maxillofac Implants 2014;29: 186–215.
4. BATINJAN G, FILIPOVIC ZORE I, VULETIC M, RUPIC I SAUDI MED J,The use of ozone in the prevention of osteoradionecrosis of the jaw. 2014;35(10):1260-1263.
5. EL HADARY A. A, YASSIN H.H, MEKHEMER S. T., HOLMES J.C., GROOTVELD M. Evaluation of the effect of ozonated plant oils on the quality of osseointegration of dental implants under the influence of Cyclosporin A an in vivo study. J. Oral Implantol. 2011;37(2):247–257.
6. GREENE A. K, FEW B.K, SERAFINI J. C. A comparison of ozonation and chlorination for the disinfection of stainless-steel surfaces. J Dairy Sci, 1993; 3617-3620.
7. V. BOCCI, Ozone as Janus. this controversial gas can be either toxic or medically useful. Mediators Inflamm, 2004;13 (1):3-11.
8. SINGH M, KUMAR L, ANWAR M, CHAND P. Immediate dental implant placement with immediate loading following extraction of natural teeth. Natl J Maxillofac Surg. (2015); 6 (2): 252-55.
9. WHEELER S. L. Implant complications in the esthetic zone. J Oral Maxillofac Surg 2007; 65: 93102
10. ZECHNER W, TANGL S, FUTST G, TEPPER G, THAMS U, MAILATH G. Osseous healing charachteristics of three different implant types. Clin Oral Implants Res. 2003;14: 150-57.
11. CORNELINI R, SCARANO A, COVANI U, PETRONE G, PIATTELLI A. Immediate one stage post extraction implant: a human clinical and histologic case report. Int J.

Oral Maxillofac Implants 2000; 15: 4327.
12. OZDEMIR E, LIN S, AND ERKUT S. Management of interproximal soft tissue with a resin bonded prosthesis after immediate implant placement: A clinical report. J Prosthet Dent 2012; 107:7-10.
13. COOPER F, RAHMAN A, MORIARTY J, CHAFFEE N AND SACCO D. Immediate mandibular rehabilitation with endosseous implants: simultaneous extraction, implant placement, and loading. Int J Oral Maxillofac Implant .2002; 17:517-25.
14.ANITHA K, KUMAR SS, BABU MR, CANDAMOURTY R, THIRUMURUGAN. Immediate implants in anterior maxillary arch. J Nat Sci Biol Med. 2014;5(1):82-9.
15. KAZANCIOGLU HO, EZIRGANLI S, DEMIRTAS N. Comparison of the influence of ozone and laser therapies on pain, swelling, and trismus following impacted third-molar surgery. Lasers Med Sci 2014;29:1313-9.
16. BUSER D, CHAPPUIS V, KUCHLER U, BORNSTEIN MM, WITTNEBEN JG, BUSER R, ET AL. Long-term stability of early implant placement with contour augmentation. J Dent Res 2013; 92: 176-82.
17. LINDQUIST L. W, ROCKLER B, CARLSSON GE. Bone resorption around fixtures in edentulous patients treated with mandibular fixed tissue-integrated prosthesis. J Prosthet Dent 1988; 5: 59-63.
18. BOCCI ,V, LUZZI E, CORRADESCHI F, SILVESTRI S. "Studies on the biological effects of ozone: 6. Production of transforming growth factor by human blood after ozone treatment". J Biol Regul Homeost Agents. 1994; 8: 108-112.
19. CROMACK D. T, PORRAS-REYES B, PURDY J. A, PIERCE GF, MUSTOE TA. "Acceleration of tissue repair by transforming growth factor beta1: identification of in vivo mechanism of action with radiotherapy-induced specific healing deficits". Surgery 1993; 113: 36-42.
20. IMAN M. S., MATAR, AHLAM M., EL-SHARKAWY NEVEIN SH.MOHAMED ,MOHAMAD N. MAWSOUF .Clinical and radiographic evaluation the effect of ozone therapy on tissue surrounding implant retained mandibular overdentures .Revista Española de Ozonoterapia .2016; 8:51-62.
21. SUNNEN G. V. Ozone in medicine: Overview and future directions. Journal of Advancement in Medicine 1988; 1: 159-174.
22.TRAVAGLI V, ZANARDI I, BOCCI V. Topical applications of ozone and ozonized oils as antiinfective agents: an insight into the patent claims. Recent Pat Antiinfect Drug Discov. 2009; 4: 130-142
23. MOHAMED ST, SHARARA AA, RAGAB HR, ZAHRAN NM. Evaluation of Topical Ozone Therapy on Healing of MandibularBony Defects. Alexandria Dental Journal. 2015; 40:148-152
24. TRINDADE R, ALBREKTSSON T, TENGVALL P, WENNERBERG A. Foreign body reaction to biomaterials: on mechanisms for buildup and breakdown ofosseointegration, Clin. Implant Dent. Relat. Res. 2016;192– 203.
25. KARACA I. R, ERGUN G, OZTURK D.N.Is Low-level laser therapy and gaseous ozone application effective on osseointegration of immediately loaded implants? Niger J. Clin. Pract. 2018;703–710.
26. YÜCESOY T, SEKER E. D, CENKCI E, YAY A, ALKAN A.Histologic and Biomechanical Evaluation of Osseointegrated Miniscrew Implants Treated with Ozone Therapy and Photobiomodulation at Different LoadingTimes. Int. J. Oral Maxillofac Implants .2019; 34:1337– 1345.