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Effectiveness of Hydroxyapatite Reinforced Chitosan Hydrogel in Modulation of Osseointegration Around Immediate Dental Implant (Randomized Single Blind Control Study)

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ABSTRACT

Aim: to evaluate effectiveness of hydroxyapatite reinforced chitosan hydrogel in modulation of osseointegration round immediate dental implant in a randomized single blind control study. **Subjects and methods:** parallel arm, single blind randomized control clinical trial A total of 20 healthy patients of either gender aged from 20-50 years who are seeking extraction and placement of immediate dental implant for mandibular teeth. Randomly assigned to either test group IMH were injection of chitosan/ hydroxyapatite hydrogel into extraction socket prior to immediate implant placement or Control group (IMC) were conventional immediate implant placement was applied. Clinical assessment of (postoperative pain, infection and swelling), implant 1ry and 2ry stability evaluation and radiographic assessment via CBCT at 3 and 6 months postoperative. **Results:** Both groups showed significant increase in implant stability from initial placement to 6 months mark where p value <0.001 for both groups, though Group IMH showed a more substantial increase in stability values over this period. Both groups demonstrated significant increases in bone density across all time intervals with p<0.001. Group IMH demonstrated superior outcomes in terms of bone density by the 6-month mark. **Conclusion:** hydroxyapatite reinforced chitosan hydrogel used with immediate implants provided less patient discomfort, improved implant stability and has positive effect on bone density.

KEYWORDS

Hydroxyapatite, Chitosan, Osseointegration, Immediate Implant.

INTRODUCTION

The dental implant is now regarded as an indispensable treatment modality in clinical dental practice. The ongoing modifications and innovations in this field has elevated the survival rate to exceed 90%; Modern oral implantology has utilized different implant size, shape, length, thickness and composition; from pure titanium to titanium-aluminum-vanadium alloys; this treatment modality has gained a well-deserved popularity with in the field of dentistry due to their biocompatibility and high corrosion resistance [(1)]**.** Immediate implant; a procedure involving placement of implant in freshly extracted sockets; gaining more attention over the traditional dental implant as it

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reduces physiological resorption of alveolar ridge, provides fast and simple procedure, decreases the dental appointment; number of visits and time; and provides more accurate axial orientation of the implant. [2, 3]

Both bioactivity and osseointegration capacity and biological response of tissues can be improved by different surface treatments. Many materials have been advocated for boosting up and enhancing the bone regeneration.[4] Bone grafts, bone substitutes, membranes, growth factors all have been utilized for this purpose. Bone grafts - natural or synthetic- materials that can provide structural support and biological cues for bone regeneration. Bone substitutes are synthetic materials that can mimic the properties and functions of natural bone. Membranes are barriers that can prevent the invasion of soft tissues and favor the growth of bone cells. Growth factors are molecules that can stimulate bone formation and angiogenesis

Osseointegration over the implant surface along with the antibacterial activity for prolonged periods of time; either by blocking microbial adhesion and/or preventing late infections are both gaining much attention for optimum success rates.[5] Natural polymers are widely used materials for bone grafting due to their biocompatibility and biodegradability. Among them, chitosan, collagen, silk fibroin, gelatin, cellulose, alginate. Chitosan not only is an excellent material for bone reconstruction but also possesses antimicrobial properties. Additionally, it can generate porous structures allowing osteoconduction, and enhance osteoblast cell proliferation. Furthermore, its structure simulates the glycos-amino-glycans of the extracellular matrix of bone.[6,7,8]

Nano- hydroxyapatite bone graft material (Nano Bones) is a recently developed granular material composed of nano-crystalline HA in a gel of silica matrix which offers many advantages related to its nano-structural where it has open SiOH or SiO groups of poly-silicic acid, with about (84 m2/g) internal surface which is regarded extremely large and the silica gel with pores ranging from 10 to 20nm, leading to material porosity of about 60% possesses high strength under tension which can reach up to 40 Mpa [9, 10, 11, 12].

Many chitosan formulas for bone tissue engineering have been introduced, including scaffolds, sponges, hydrogels, micro-nano-spheres, and membranes [13]; all capable of accelerating the formation of new bone within the host bone without causing adverse reactions[14]. Many studies investigating chitosan-based gel scaffolds for bone regeneration can be found in the literature. Further, it has become popular to develop systems that combine chitosan with other compounds as hydroxyapatite to improve properties such as osteoconductivity and mechanical properties and thus obtain materials that simulate natural osseous structure as much as possible moreover improved the protein adsorption capacity and accelerate osseointegration.[15] Hydrogels have also found their way into many surgical applications. The unique composition of hydrogel which generally consist of a 90% liquid phase, and a solid phase that gives the gel its structure consistency. [16] The high water content grants this material its biocompatible, and their soft consistency prevents damage to surrounding tissues. Chitosan hydrogels provides mechanical properties mimicking that of connective tissues, which favors tissue regeneration[17].

Thus the null hypothesis is that there is no difference in osseointigration when using hydroxyapatite reinforced chitosan hydrogel in combination with immediate implant versus immediate implant only

PARTICIPANTS AND METHODS

Ethical regulations and study design

The present randomized clinical trial was a single blinded two grouped parallel armed study design with ratio 1: 1; following the CONSORT guideline for clinical trials Fig (1) the study received Ethics Committee approval from Faculty of Dentistry, Minia University- Egypt; under ID (94/ 715) and was registered on ClinicalTrials.gov registry with ID/ (NCT 06758440). All patients were acquainted

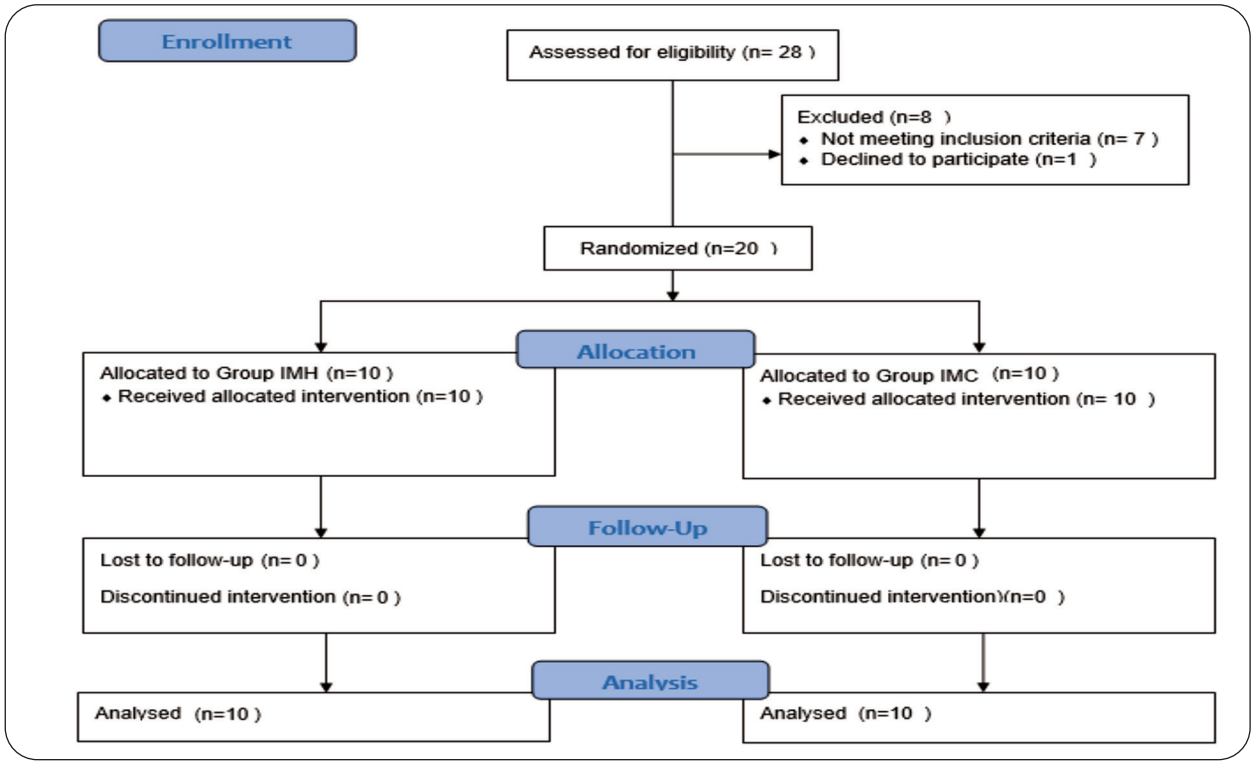

Fig. (1) *CONSORT flow chart of the study*

and briefed about the risks, benefits and steps of the study intervention. Then all participants signed a consent form.

Sample size calculation

A power analysis according to previous study [18] was designed to have adequate power to applied to the null hypothesis that there would be no difference found between test and control groups Sample size calculation was performed using G*Power version 3.1.9. The least possible number was calculated at a total of 16 cases and increased by 10% to 20 cases to cover for any dropout (10 cases for each group)

Selection of participants and Recruitment strategy:

Consecutive sampling was done selecting 20 patients from outpatient clinic according to predetermined Inclusion criteria as following: healthy patients (class I category according to American society of anesthesiologists), age (20- 50y), of either, seeking extraction and placement of immediate dental implant for mandibular teeth. Any patients with acute infection in the implant insertion sites, aggressive periodontal disease, allergy to any of the materials used in the study, patients with severely resorbed ridges in need of a grafting procedure, patients with significant medical condition, and those who were pregnant or lactating were excluded.

Randomization, blinding

A computer software generated randomization sequence was generated (Microsoft Excel) where both groups IMH and IMC were denoted and randomly allocated. The table is kept with the co-supervisor. Allocation – concealment mechanisms using opaque sealed envelopes placed in a box was then done and the participant was allowed to select an envelope then the opened it up and the patient was notified of the treatment to be applied. The practitioners that will evaluate clinically and radiographically the outcome was blinded to the type of treatment the case was assigned to.

Grouping of The Study

A total of Twenty healthy participants were equally randomly allocated to either of the study groups: Group IMH (10 patients), who received a mixture of HA/CS hydrogel with ratio 1:1:1 of nano-hydroxyapatite grafting material (NanoBone® Bone Graft Substitute, Artoss GmbH, Rostock, Germany , chitosan based hydrogel (MaxioCel Wound Gel-AXIO- P18- Gujarat Pharma Tech- India) and hydrogel (ORA Soothe Gel- MCMP, LP, 1610W-USA) in to the extraction socket prior to immediate implant placement(Spectra system -Inc./NV 89149, CA. USA.) and then covered with HemCon dental dressing Pro (Tricol Biomedical, Inc. USA). Group IMC (10 patients), serving as a control group who received a dental immediate implant Spectra system (Inc./ NV 89149, CA. USA).

The Surgical Intervention

The procedure was commenced on the dental chair under local anesthesia with inferior alveolar and buccal nerve block using (4% Articaine / 1: 100000 epinephrine). A Gingival (sulcular) muco-periosteal incision around the neck of the tooth at the tooth to be extracted and extended mesial and distal to the adjacent teeth allowing adequate exposure of the implant insertion site. Whilst preserving all available alveolar bone; particularly the labial and buccal wall; tooth extraction was done in an atraumatic manner. The socket was prepared to receive the immediate implants of Spectra system (Inc / NV 89149, CA. USA.), thoroughly debrided by careful curettage and copiously irrigated with sterile saline to flush out any infected or inflammatory tissues. The implant bed was drilled at the base of the extraction socket utilizing the drilling sequence according to manufacturer's recommendation. For group IMH 1ml of the prepared mixture HA/CS hydrogel in the extraction socket in a back fill injection manner prior to immediate implant placement which was seated with the aid of a manual ratchet and then covered with HemCon dental dressing Pro (Tricol/ Biomedical, Inc. USA)

For the control Group IMC (10 patients); the same surgical procedure was performed as the previous group without applying the HA/ CS hydrogel only seating a dental immediate implant Spectra system (Inc/ NV 89149, CA. USA.); the jumping gaps were filled with nano-hydroxiapatite bone grafting material then covered with HemCon dental dressing Pro (Tricol Biomedical, Inc. USA)

Wound closure was done using black silk 3-0 in an interrupted suture manner and patients were instructed to apply ice bag to the surgical side. Medications prescribed included Amoxicillin 875mg + Clavulanic acid 125mg every 12 hours for 5 days (AUGMENTIN: GalaxoSmithKline, UK). Diclofenac potassium 50 mg every 8 hours for 3 days, then when needed (CATAFLAM: diclofenac potassium 50mg: Novartis - Switzerland). Chlorhexidine antiseptic mouth wash two times daily after the first day and for 1 week (HEXITOL: Arabic drug company, ADCO). Sutures were removed one-week post-surgery

Postoperative evaluation

Clinical Assessment

a. Post-operative pain was assessed through the ten-point visual analogue scale where the patient was educated to keep a diary to record pain at (24 h, 48h, 7d, 14d and 21d).

b. A blinded practitioner examined the surgical site to record the presence of swelling and infection at (24h, 7d).

Implant Stability Quotient (ISQ): A blinded practitioner Measurement of implant stability was performed by Osstell ™ Osstell ISQ (Osstell AB, Göteborg, Sweden) immediately after surgery and 6 months from implant placement.

Bone Density (HU): A blinded radiologist assessed bone density in HU via CBCT (Planmeca Promax 3DMid machine, Helsinki Finland) scan which was obtained immediately postoperative, 3 and 6 months postoperatively (A mean value was

calculated of six standardized predetermined points on the surface of the immediate implant which was repeated each scan).

Statistical Analysis

Data were collected and analyzed utilizing Statistical Package for Social Science (SPSS) program, all statistical analysis was performed by an independent statistician blinded to the grouping and research design.

RESULTS

Demographic Data: Tab (1)

A total of twenty patients participated in the current study; according to the demographic data the comparison between the two groups (IMH and IMC) with 10 participants each. The age distribution showed no significant difference between Group IMH (mean 42±8.4 years, range: 29-50) and Group IMC (mean 44.1±5.9 years, range: 32-49) with p=0.523. Gender distribution was also comparable between the groups, with Group IMH having 6 males (60%) and 4 females (40%), while Group IMC had 4 males (40%) and 6 females (60%), showing no statistically significant difference at p value = 0.371.

Table (1) *Comparison of demographic data between the two groups*

		Group (IMH)	Group (IMC)	P value
		N=10	N=10	
Age	*Range*	(29-50)	(32-49)	*0.523*
	Mean ± SD	42±8.4	44.1±5.9	
Gender	*Male*	6(60%)	4(40%)	*0.371*
	Female	4(40%)	6(60%)	

- *Independent Samples T test for normally distributed quantitative data between the two groups*
- *Chi Square test for qualitative data between the two groups*
- *Significant level at P value < 0.05*

Postoperative pain: Tab (2), Fig (2)

a comprehensive analysis of pain levels across multiple time points (24h, 48h, 7d, 14d, and 21d) between Groups IMH and IMC using non-parametric statistical tests. At the 24-hour mark, there was a statistically significant difference between the groups with p value =0.010, with Group IMC reporting higher median pain scores (median: 6, IQR: 4.8-7) compared to Group IMH (median: 3.5, IQR: 3-5). However, this difference became non-significant at all subsequent time points: This pattern indicates that while Group IMC experienced higher initial pain at 24 hours, both groups showed similar and effective pain reduction patterns thereafter, with pain levels becoming negligible by the 14-day mark and remaining so through 21 days.

Table (2) *Comparison of pain scores between the study groups at different times.*

Pain score		Group (IMH)	Group (IMC)	P value
		N=10	N=10	
At 24h	*Median*	3.5	6	***0.010****
	IQR	(3-5)	(4.8-7)	
At 48h	*Median*	2	3	*0.130*
	IQR	(2-3)	(2-4)	
At 7d	*Median*	1	1	*0.483*
	IQR	(1-2)	(1-2)	
At 14d	*Median*	0	0	*0.146*
	IQR	(0-0)	(0-0.3)	
At 21d	*Median*	0	0	*1*
	IQR	(0-0)	(0-0)	
P value		***<0.001****	***<0.001****	

- *Mann Whitney test for not normally distributed quantitative data between the two groups.*
- *Friedman's test for not normally distributed quantitative data between different times within each group, followed by Wilcoxon Signed rank test between each two times.*
- **: Significant level at P value < 0.05*

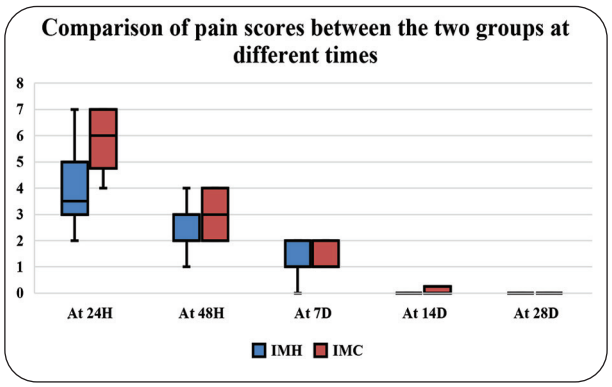

Fig. (2) Box plot showing comparison of VAS between different groups

Swelling assessment: Tab (3)

The occurrence of swelling at two time points (24 hours and 7 days) between Groups IMH and IMC. At 24 h post-procedure, Group IMH showed a lower incidence of swelling with only 1 case (10%) compared to Group IMC with 3 cases (30%); however, this difference was non- significant (p=0.264). By day 7, both groups showed complete resolution of swelling with 0% incidence in both groups (p=1). When comparing the changes within each group between 24 hours and 7 days, neither group showed statistically significant changes (Group IMH: p=1, Group IMC: p=0.250). These findings suggest that while Group IMC initially showed a trend toward higher swelling incidence at 24 hours, both groups achieved complete resolution of swelling by day 7, indicating effective management of post-procedural swelling regardless of the treatment approach.

Infection assessment: Tab (4)

At 24 hours, Group IMH demonstrated a lower infection rate with 1 case (10%) compared to Group IMC with 3 cases (30%), though this difference was non- significant with p value =0.264. By day 7, both groups showed complete resolution of infection with 0% incidence (p=1). The within-group analysis between 24 hours and 7 days showed non- significant changes (Group IMH: p=1, Group IMC: p=0.250). These results indicate that while Group IMC initially showed a trend toward higher infection rates at 24 hours, both groups achieved complete resolution of infection by day 7, suggesting effective infection control protocols in both treatment approaches.

Table (3) *Comparison of swelling incidence between the study groups at different times.*

Swelling		Group (IMH)	Group (IMC)	P value
		N=10	N=10	
At 24h	*No*	9(90%)	7(70%)	*0.264*
	Yes	1(10%)	3(30%)	
At 7d	*No*	10(100%)	10(100%)	*1*
	Yes	0(0%)	0(0%)	
P value		*1*	*0.250*	

- *Chi Square test for qualitative data between the two groups*
- *McNemar test for qualitative data between the two times within each group.*
- *Significant level at P value < 0.05*

Table (4) *Comparison of infection incidence between the study groups at different times.*

Infection		Group (IMH)	Group (IMC)	P value
		N=10	N=10	
At 24h	*No*	9(90%)	7(70%)	*0.264*
	Yes	1(10%)	3(30%)	
At 7d	*No*	10(100%)	10(100%)	*1*
	Yes	0(0%)	0(0%)	
P value		*1*	*0.250*	

- *Chi Square test for qualitative data between the two groups*
- *McNemar test for qualitative data between the two times within each group.*
- *Significant level at P value < 0.05*

Implant stability: Tab (5), Fig (3)

Both groups showed similar immediate implant stability measurements, with Group IMH at

64.6±3.5 (range: 59-69) and Group IMC at 63.2±3.5 (range: 59-68), showing no significant difference (p=0.382). However, at the 6-month follow-up, there was a statistically significant difference between the groups at p value =0.003, with Group IMH showing higher stability values (83±5.1, range: 73-89) compared to Group IMC (75.1±5.1, range: 69-83). Notably, both study groups showed significant improvement in implant stability from immediate placement to 6 months (p<0.001 for both groups), though Group IMH showed a more substantial increase in stability values over this period.

Table (5) *Comparison of implant stability between the two groups at different times.*

Implant stability		Group (IMH)	Group (IMC)	P value
		N=10	N=10	
Immediate	*Range*	(59-69)	(59-68)	*0.382*
	Mean ± SD	64.6±3.5	63.2±3.5	
At 6 months	*Range*	(73-89)	(69-83)	***0.003****
	Mean ± SD	83±5.1	75.1±5.1	
P value		***<0.001****	***<0.001****	

- *Independent Samples T test for normally distributed quantitative data between the two groups.*
- *Paired Samples T test for normally distributed quantitative data between the two times within each group.*
- **: Significant level at P value < 0.05.*

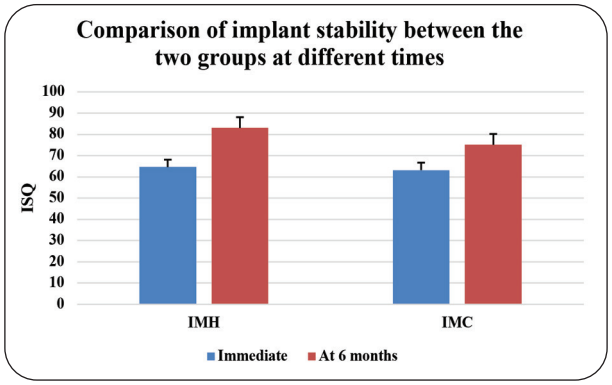

Fig. (3) Bar chart showing implant stability between group IMH and IMC immediately postoperative and after 6months.

Bone Density: Tab (6), Fig (4)

The analysis revealed identical baseline measurements for both groups (Group IMH: 566.7±68.6, range: 475-670; Group IMC: 566.7±66.3, range: 480-669; p=1.000). At 3 months, though Group IMH showed slightly higher values (741.8±63.3, range: 650-821) compared to Group IMC (722.7±65.3, range: 629-798), this difference was non- significant at p value =0.515; However, at 6 months, there was a highly significant difference between the groups with a p value <0.001, with Group IMH showing markedly higher bone density (959±27, range: 910-987) compared to Group IMC (858.6±58, range: 771-951). Both groups demonstrated significant increases in bone density across all time intervals (immediate vs. 3 months, immediate vs. 6 months, and 3 months vs. 6 months), with p<0.001 for all comparisons within each group. The data suggests that while both groups showed improvement over time, Group IMH demonstrated superior outcomes in terms of bone density by the 6-month mark.

Table (6) *Comparison of bone density between the two study groups at different times.*

Bone Density		Group (IMH)	Group (IMC)	P value
		N=10	N=10	
Immediate	*Range*	(475-670)	(480-669)	*1*
	Mean±SD	566.7±68.6	566.7±66.3	
At 3months	*Range*	(650-821)	(629-798)	*0.515*
	Mean±SD	741.8±63.3	722.7±65.3	
At 6months	*Range*	(910-987)	(771-951)	***<0.001****
	Mean±SD	959±27	858.6±58	
P value		***<0.001****	***<0.001****	
(Immediate vs 3 months)		***<0.001****	***<0.001****	
(Immediate vs 6 months)		***<0.001****	***<0.001****	
(3 months vs 6 months)		***<0.001****	***<0.001****	

- *Independent Samples T test for normally distributed quantitative data between the two groups.*
- *Repeated measure ANOVA test for normally distributed quantitative data between different times within each group, followed by Post Hoc analysis between each two times.*
- **: Significant level at P value < 0.05.*

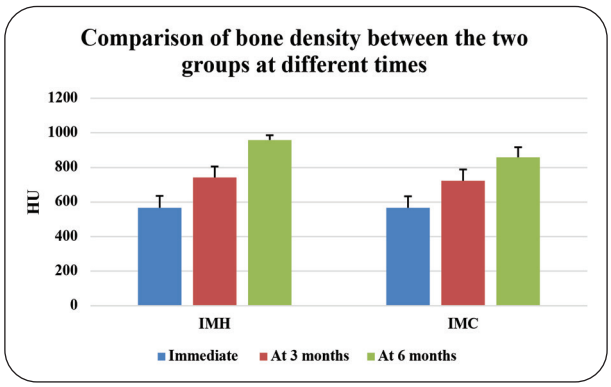

Fig. (4) Bar chart showing bone density of group IMH and IMC at different time interval

DISCUSSION

Immediate implant is a multidisciplinary and sensitive process. The ongoing request in such procedure is to reduce healing period before loading which mostly depends on osseointegration. Many techniques have been integrated to encourage osseointegration via enhancing cell adhesion, proliferation, and differentiation boosting osteogenesis at implant surface

The material used in the present study for test group (IMH) is a mixture of nano- hydroxyapatite grafting material (NanoBone® Bone Graft Substitute, Artoss GmbH, Rostock, Germany), chitosan based hydrogel (Wound Gel- AXIO- P18- Gujarat Pharma Tech- India) and hydrogel (ORA Soothe Gel- MCMP, LP, 1610W- USA) in a 1:1:1 ratio. This mixture was inserted into the prepared socket for the immediate implant. This current study aimed to evaluate the benefits of hydroxyapatite reinforced chitosan hydrogel in regards of post-operative pain control, implant stability and bone density.

Regarding the post-operative pain at the 24-hour mark, there was a statistically significant difference between the groups at a p value of 0.010, with Group IMC reporting higher median pain scores (median: 6) compared to Group IMH (median: 3.5). this indicates the pain relieving effect of the HA/CS hydrogel

Regarding chitosan component used in group IMH; many studies have shown its pain alleviation properties **Malmquist etal.** [19] whom previously evaluated the postoperative pain after utilizing the chitosan dressing in dental extraction socket and found it to be superior than control group where no dressing was applied. Inferring that chitosan provided acceptable pain control following extraction.

de Jesus etal[20] conducted a split-mouth study to evaluate chitosan influence on healing process following oral surgeries where chitosan hydrogel was placed into the extraction socket and other without applying the biomaterial. They came to conclude that Chitosan hydrogel allowed accelerated wound healing and reduced postoperative pain. The analgesic effect of chitosan is due to its capacity to absorb bradykinin and modulate many cytokines involved in pain pathway [21]

In addition to the hydrogel (ORA sooth); typically used in dry socket treatment; which is consisted entirely of food ingredients, with no artificial constituents; contains aloe Vera, mannose polysaccharides, xylitol. This hydrogel supplies nutrients to cells involved in wound healing and is effective against oral pathogens providing a hydrated environment that promotes optimal wound healing. On a molecular level it is capable of alleviate pain as it bonds to sodium ions at the site of injury and inhibit their passage through the nerve membrane. This stops the initial step in membrane depolarization and helps prevent the generation and/or propagation of a nerve impulse. [22,23]

As for both (swelling and infection); non-significant difference was found between the two groups and complete resolution; at 7 days; was reached. For the test group(IMH) only one case showed signs of swelling and infection; this extremely low incidence may be attributed to both the chitosan and hydrogel (ORA sooth) that were used in the test group. Chitosan possesses a remarkable antimicrobial activity. Many studies

documented the efficacy of chitosan against both Gram -ve and Gram + ve bacteria. Moreover, it has the ability to form; by binding to anions on the bacterial surface; a poly-cationic structure. That leads to weakening the outer membrane barrier function and permeability of microorganisms subsequently; destroying bacteria providing an encouraging environment for osseointegration[24]. As for the control group case IMC only three cases showed initially mild signs of swelling and infection that totally underwent resolution by one week postoperatively. Which is predictable as all patients were already under systemic antibiotic coverage.

Results of both implant stability and bone density; in the current study; have highlighted the superior results of combining immediate implant with HA/ CS hydrogel. At the 6-month follow-up Group IMH showing higher implant stability values compared to Group IMC. Additionally; all through the study period HA/CS hydrogel significantly enhanced bone density around the immediate implant; at 6 months; Group IMH showing significantly higher bone density compared to Group IMC. The data suggests that while both groups showed improvement over time, Group IMH demonstrated superior outcomes in terms of bone density by the 6-month mark. This indicates the advantageous effect of combining HA/CS hydrogel with immediate implant. Hydroxyapatite nano-particles have long been demonstrated to enhance bone regeneration and in cases of implant increases osseointigration as previous studies have stated. **Khaled etal**[25] demonstrated; in a sinus lifting procedure; bone formation the results showed that bone density values of newly formed bone after sinus lifting procedures using HA nano- particles were superior compared to sinus lifting using tenting procedures.

Also in agreement with **Hommos etal** [26] who conducted a randomized controlled study on 30 cases who required implant placement in atrophied maxillary ridge. They compared immediately placement of implants with and without nano-hydroxyapatite (HA) bone graft. The results showed that grafting with nano HA was superior in terms of bone formation, rigidity, toughness, dimensional stability, and biocompatibility.

Nano- hydroxyapatite bone graft materials (Nano Bone) are synthetic material composed of 74% slow resorbing nanocrystal un-sintered hydroxyapatite in a 24% micro-porous silica gel matrix. According to **Bienengraber etal** [27] nano-hydroxyapatite and due to its nanostructure demonstrates accelerated bone formation and by time is completely remodeled which is an evident sign of its high performance. **Gotz et al** [28] investigated immunohistochemically the effect of applying HA in bony defects. They found that the HA was enhanced osteoconductivity, while the silica gel stimulated connective tissue regeneration, osteoblast proliferation, matrix mineralization and calcification, so it is a combination of osteoconductive and osteoinductive properties.

Implant stability is a fundamental criteria and important factors in achieving implant success and osseointegration. [29, 30]

These results are in agreement with **Vanden Bogaerde etal** [31]**, Villa and Rangert** [32] **and Crespi et al** [33]**;** They studied various factors in immediate implants placement; early and late loading, with and without application of bone graft and in different regions of the mandible/ maxilla arch; the results revealed that after 6 months the measurement of ISQ was 60- 63 indicating high implant stability.This increase in the implant stability may be attributed to the fact that acceptable bone density was reached by the sixth month post implant insertion which indicates successful osseointigration

In agreement with **Jang et al (34)** whom used hydroxyapatite ability to induce bone regeneration using two forms. They concluding that fast and more uniform bone formation in alveolar sockets was obtained when using the HA.

In the present study not only did we use nano-hydroxyapatite graft material but a chitosan hydrogel

which is typically applied to surgical wounds and ulcers; this mixture has been previously mentioned in various studies and has been proven to heighten and enhance bone regeneration and accelerate healing

Dhivya etal [35] examined an injectable thermos-sensitive hydrogel containing chitosan/ nano-hydroxyapatite for its effectivity toward new bone formation at both molecular and cellular levels in vitro and in vivo. The results revealed remarkable bone formation and recommended adding chitosan/ nano-hydroxyapatite particle to the hydrogel to provide accelerated healing process of bony defects subsequently providing a potentially reliable clinical application for bone regeneration.

The results of the present study provided that this HA/CS hydrogel improved the implant stability and bone density around immediate implant; Thus the null hypothesis was rejected.

Declaration of interests

The study is self-funded and there is no conflict of interest to declare.

CONCLUSION

Hydroxyapatite reinforced chitosan hydrogel used with immediate implants provided less patient discomfort, improved implant stability and has positive effect on bone density.

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فعالية هيدروجيل الشيتوزان المقوى بالهيدروكسي أباتيت في تعديل الاندماج العظمي حول غرسات الأسنان الفورية تجربة عشوائية فردية التعمية

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الملخص :

الهدف: تقييم فعالية هيدروجيل الكيتوزان المعزز بهيدروكسي أباتيت في تعديل التكامل العظمي حول غرسة الأسنان الفورية، وذلك في دراسة عشوائية أحادية التعمية.

المواد والاساليب: تجربة سريرية عشوائية أحادية التعمية، ذات ذراع متوازي. شملت الدراسة 20 مريضًا سليمًا من كلا الجنسين، تتراوح أعمارهم بين 20 و50 عامًا، ممن يسعون لخلع وتركيب غرسة أسنان فورية في الفك السفلي. تم توزيع المرضى عشوائيًا على مجموعتين: مجموعة الاختبار (IMH) التي حُقنت بمادة هيدروجيل الكيتوزان/هيدروكسي أباتيت في تجويف الخلع قبل وضع الغرسة فورًا، ومجموعة الضبط (IMC) التي طُبقت فيها الغرسة الفورية التقليدية. تم إجراء تقييم سريري للألم والالتهاب والتورم بعد الجراحة، وتقييم ثبات الغرسة (1RY و2RY)، وتقييم شعاعي باستخدام التصوير المقطعي المحوسب المخروطية (CBCT) بعد 3 و6 أشهر من الجراحة.

النتائج: أظهرت كلتا المجموعتين زيادة ملحوظة في ثبات الغرسة من الزرع الأولي وحتى 6 أشهر، حيث كانت قيمة الاحتمالية (P) أقل من 0.001 لكلتا المجموعتين، على الرغم من أن مجموعة (IMH) أظهرت زيادة أكبر في قيم الثبات خلال هذه الفترة. أظهرت كلتا المجموعتين زيادات ملحوظة في كثافة العظام على جميع الفترات الزمنية، حيث كانت قيمة الاحتمالية أقل من 0.001. وأظهرت المجموعة IMH نتائج أفضل من حيث كثافة العظام بعد ستة أشهر.

الخلاصة: أدى استخدام هيدروجيل الكيتوزان المعزز بهيدروكسيباتيت مع الغرسات الفورية إلى تقليل انزعاج المريض، وتحسين ثبات الغرسة، وكان له تأثير إيجابي على كثافة العظام.

الكلمات المفتاحية: هيدروكسيباتيت، الكيتوزان، الاندماج العظمي، الغرسة الفورية.