



Evaluation of Socket Preservation Using A Synthetic Nanocrystalline Hydroxyapatite

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KEYWORDS

Socket Preservation, CBCT,
Nano Hydroxyapatite,
Collagen Membrane,
3-D Measurement.

ABSTRACT

Aim: This study was designed to evaluate the socket preservation using a synthetic nanocrystalline hydroxyapatite followed by collagen membrane. **Subjects and methods:** Fourteen patients were selected from Oral and Maxillofacial clinic of the Faculty of Oral and Dental Medicine, Al-Azhar University, Cairo, Boys. Extraction of tooth of lower premolar area was done to all participants. Then they were divided into 2 groups, where 7 sockets were preserved and the 7 were kept as control. After tooth extraction in the test group nanobone putty form was grafted into the socket. An additional covering was performed by a collagen membrane. A cone beam computed tomography (CBCT) radiograph at 3 and 6 months were done to assess bone density and socket dimensions. All readings were recorded and analyzed statistically. **Results:** Among the study group, there is a high statistically significant difference between the three measurements (soon after extraction, after 3- and 6- months from operation) as regards the mean of bone density and the three dimensions. **Conclusion:** Nano hydroxyapatite together with collagen membrane to seal the socket accelerates the formation of bone filling in the extracted bony socket

INTRODUCTION

Postextraction alveolar ridge resorption is a common phenomenon that impairs placement of dental implant and may cause esthetic problems in prosthetic dentistry^(1,2).

Resorption of buccal/lingual walls of the extraction site occurs in two overlapping phases. During the early phase of remodeling, the bundle bone undergoes resorption and replaced by woven bone. Since the crest of the buccal bone is comprised solely of bundle bone, this remodeling will result in substantial vertical reduction of the buccal bone crest. Moreover, resorption occurs from the outer surfaces of both bone walls⁽³⁻⁶⁾.

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It has been shown that autogenous bone grafts are the gold standard for the treatment of segmental bone defect but the surgical morbidity as well as bone sources limitation and the need for the second surgery have reduced their frequent use ⁽⁷⁾. Moreover, allografts bone has been suggested to be used but probably immunological responses restrict its use ⁽⁸⁾.

Different material has been used in order to solve these problems; synthetic biocompatible bone substitutions that become the most widely used. These materials consist of calcium, phosphate, ceramics and organic materials; it can provide a stable scaffold for appropriate bone response and subsequent bone repair ⁽⁹⁾.

NanoBone developed by Artoss* company, is basically nanocrystalline HA embedded in silica gel matrix. Features such as interconnecting pores on the nanoscale, the open SiOH or SiO groups of polysilicic acid, has large internal surface, and the high porosity that may related to the calcification process observed within the implantation bed ^(10,11). While the HA component is responsible for osteoconductive properties, the silica component is believed to induce connective tissue formation, osteoblast proliferation, bone matrix mineralization, and calcification, thus combining osteoconductive and osteoinductive properties ⁽¹¹⁻¹³⁾.

This phenomenon is associated with the rearrangement of the silica matrix, which could be observed in vivo ^(13,14).

Based on the observations gained from several clinical studies that confirming the properties of nanocrystalline HA. This study is designed to evaluate the outcomes of using nanocrystalline hydroxyapatite in socket preservation ⁽¹⁵⁻¹⁷⁾.

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AIM OF THE STUDY

The aim of the present study was to evaluate the Socket preservation using a synthetic nanocrystalline hydroxyapatite followed by collagen membrane.

PATIENT AND METHODS

In this study, 14 patients (7 males and 7 females) with age range was between 20 to 38 years were selected from Oral and Maxillofacial clinic of the Faculty of Oral and Dental Medicine, Al-Azhar University, Cairo, Boys. Extraction of tooth of lower premolar area was done to all participants. Then they were divided into 2 groups, where 7 sockets were preserved and the other 7 were kept as control.

Selection criteria:

- **Inclusion criteria:** Patient with decayed lower premolar with adequate bone at least 3-4 mm beyond the apex of the tooth
- **Exclusion criteria:** Soft tissue recession at the extraction site and un-cooperative patients.

A -Preoperative phase

All patients underwent pre-operative clinical examination: Patients' data were collected; name, gender and age, medical and dental histories were taken. Also, all patients underwent periapical radiograph to exclude any pathosis and evaluate the dimensions of the socket

B -Operative phase

- After local anesthesia had been administered, sulcular incisions were given around the premolars with a sharp instrument such as a No.15 scalpel.
- Periosteal elevator was used to dissect the attached fibers. The blade had to be angled at 20 degrees to ensure that the tip of the periosteal elevator was within the crest of the alveolar bone.



- The instrument was inserted first in the gingival sulcus and then in the periodontal ligament space. The periosteum was moved repeatedly in a mesio-distal direction, along the circumference of the root.
- Finally, the extraction of the tooth was performed with forceps without distorting or damaging the alveolar bone.
- After extraction, all patients underwent CBCT imaging.
- After tooth extraction in the control group, the soft and hard tissues were curetted and sutured (Fig 1).
- In the test group, nanobone putty form was grafted into the socket up to 2 mm apical to the soft tissue margin.
- An additional covering of the surgical site was performed by means of a collagen membrane (Hypro-Sorb F) (fig.2)



Fig. (1) Lower left first premolar socket after atraumatic extraction (among control group)



Fig. (2) Nanobone putty form and resorbable collagen membrane adaptation

C-Postoperative phase

Postoperative medications:

The standard postsurgical instructions were given to the patient. A list of drugs was then prescribed to the patients as following: Amoxicillin (Amoxil™) 500 mg capsules (t.d.s) for 7 days / Metronidazole (Flagyl®) 500 mg tablets (t.d.s) for 7 days / Ibuprofen (Brufen®) 600 mg tablets (t.d.s) for 3 days and then when necessary / Chymotrypsin + trypsin (Alphintern®) tablets (t.d.s) half an hour before meals for 7 days. Patients were instructed to rinse their mouths twice daily with a solution of 0.1% chlorhexidine gluconate (Antiseptol solution) for 10 days.

Postoperative instructions:

1st day instructions: All patients informed to do the following:

- Bite on the pack for 30 min. and then remove it.
- Cold fomentation (10 minutes on, every 30 minutes off.)
- Never to eat hard, spicy foods or drink hot drinks.
- Never to suck anything (include smoking, Shisha)
- Never use any mouth wash.

2nd day instructions: Patients instructed to follow the 1st day instructions but without cold fomentation and they washed their mouth by 0.1% chlorhexidine gluconate mouth wash & sterile saline.

D- Follow up phase

Bone density and socket dimensions were evaluated after the treatment by using a cone beam computed tomography (CBCT) radiograph at 3 and 6 months following treatment, to assess bone density and vertical, horizontal and bucco-lingual dimensions

- Bone Density Assessment: By using beam CBCT software, the change in density of the graft was calculated in Hounsfield units (HU). The mean values of bone density were recorded. This process was repeated at each interval post-operative follow up.
- Socket dimensions: By using beam CBCT software, the socket dimensions were calculated in millimeters (mm). Vertical line was set parallel to the tooth axis of the tooth before extraction, and the horizontal line was set perpendicular to the vertical line. The bucco-lingual ridge heights were measured from the most apical point of the alveolar socket to the height of the crest. The mean values of the three dimensions were recorded. This process was repeated at each interval postoperative follow up.

Statistical analysis:

Data were represented as mean and standard deviation. Independent sample t-test of significance and chi square test were used when comparing between the two groups. Repeated measures analysis

of variance (ANOVA) test was used to compare numeric variables within the studied group of patients. Data were analyzed using SPSS. Result was considered statistically significant if the p- value was less than 0.05.

RESULTS

There were 14 patients included in this study]. They were classified into 2 groups, 7 patients in the study group and 7 patients in the control group. Patients' age ranged from 20 to 39 years, the mean average age was 31.64 years old in the study group and 30.81 years in the control group.

There is a highly statistically significant difference between the two groups as regards the bone density either at 3 months or 6 months of follow up.

There is a high statistically significant difference between the study and control group as regards the amount of changes occur in the measurements of bone density, vertical, horizontal and bucco-lingual dimensions soon after extraction and after 6 months from treatment ($P < 0.01$). (table 1)

Table (1) Amount of changes occur in the measurements of bone density, vertical, horizontal and bucco-lingual dimensions soon after extraction and after 6 months from treatment for the study and control group

Change from on admission to 6 months after operation		Group I	Group II	Test value•	P-value	Sig.
		No. = 7	No. = 7			
Vertical	Mean ± SD	-1.48 ±0.93	-2.99 ±0.35	4.041	0.002	HS
Horizontal	Mean ± SD	-0.65 ±0.29	-1.78 ±0.49	5.222	0.000	HS
Bucco-lingual	Mean ± SD	-0.83 ±0.49	-2.77 ±0.38	8.217	0.000	HS
Density	Mean ± SD	1216.14 ±157.32	907.71 ±69.8	4.741	0.000	HS



DISCUSSION

Tooth extraction is a traumatic procedure initiating a complex cascade of biochemical and histologic events that inevitably lead to a reduction of alveolar bone and soft tissue. ⁽¹⁸⁾ These changes at the extraction site may be due to the loss of periodontal ligament fibers, bundle bone, and loss of blood supply. These morphologic changes pose significant challenges in restorative treatment, as soft tissue recession and buccal plate resorption define the anatomical profile of the socket and may narrow the viable treatment options. ⁽¹⁹⁾ Accordingly, reconstruction of resorbed alveolar ridges has been a goal and a challenge for clinicians to create an anticipated foundation for implant placement to optimize the outcomes. ⁽²⁰⁾

As the present study suggested, successful alveolar ridge preservation procedures may reduce or eliminate the need for future ridge augmentation. This was consistent with recent data published by Nevins et al. who emphasized on the significance of bone grafting following tooth extraction in preserving buccal plate integrity and in consequence, alveolar ridge dimensions for ideal implant treatment. ⁽²¹⁾

Allograft, xenograft, and alloplastic materials, along with the autogenous bone, have been utilized in preserving the alveolar ridge. During post extraction healing, vertical and horizontal bone loss is expected, yet the use of grafting materials can provide dimensional stability to the alveolar ridge. Bone healing and subsequent new bone formation after grafting take place via osteogenesis, osteoinduction and/or osteoconduction. ⁽²²⁾

One of the used substances is Hydroxyapatite which is a good candidate for bone substitutes due to its chemical and structural similarity to bone minerals. Nanocrystalline HA exhibit greater surface area and are expected to have better bioactivity than coarser crystals. Osteoconductivity, solubility and mechanical reliability of the HA can be promoted by controlling its particle size and structural morphology in the order of nanoscale. ⁽²³⁾

In the present study, preservation of Sockets was done immediately after extraction of lower premolar area among the study group. Preservation was done by using nanobone putty form which was directly applied into the defect.

In the present study, an additional covering of the surgical site was performed by means of a collagen membrane. This was in full agreement with results of Kim et al who observed that there is higher bone density of the grafted bone among the group received bone grafting, combined with collagen membranes, results in less bone resorption than bone grafting alone. ⁽²⁴⁾ In addition, this was consistent with Lekovic et al. who compared the outcome of alveolar ridge preservation using a bioabsorbable membrane to extraction alone. At 6 months, they found significantly less crestal bone loss and less horizontal ridge in the membrane group than in the control. ⁽²⁵⁾

To promote a fair comparison between groups, special attention was given in this study to site selection during subject recruitment. Only lower premolars were included to evaluate extraction sockets of similar size, bone quality, and anatomy. This concept was done also by Neiva et al who justify the use of one site extraction in their study to minimize variables and strengthen the results obtained. ⁽⁹⁶⁾ The use of nanobone in this study based on its ability to chemically bind to bone, without inducing toxicity or inflammation and stimulating bone growth through a direct action on osteoblasts. This was in full agreement with Huang et al who did in vitro assessment of the biological response to nano hydroxyapatite and found that nHA-sprayed substrates were able to support the attachment and the growth of human osteoblast-like cells. These results indicate that nHA crystals may be suitable for intraosseous implantation and offers the potential to formulate enhanced composites for biomedical applications. ⁽²⁶⁾

In the present study, a change of the alveolar bone level was detected radiographically using

consecutive pre- and post-operative radiographs. Periapical radiograph was done before extraction to exclude any pathosis and evaluate the bone height, mesio-distal width and depth of the socket. CBCT scans were done immediately after extraction and at 3- and 6-months following treatment to assess the following parameters: bone density and vertical, horizontal and buccolingual dimensions. The results were compared with another similar control group, who didn't get socket preservation after tooth extraction. This was in full agreement with Silva et al. who prove that the CBCT images can become a reliable tool for bone density assessment. ⁽²⁷⁾

Results of the present study shows that, in the control group, without socket preservation, the reduction in vertical dimensions after 3 months was by 2.35 ± 0.34 , and after 6 months was by 2.99 ± 0.35 . While the reduction in the horizontal dimensions after 3 months was about by 1.11 ± 0.42 and after 6 months was by 1.78 ± 0.49 . Moreover, the reduction in the buccolingual dimensions after 3 months was about by 1.42 ± 0.27 and after 6 months was by 2.77 ± 0.38 . These results were consistent with a systematic review which studied the effect of socket preservation therapies following tooth extraction in non-molar regions in humans and showed that, in natural healing after extraction, a reduction in width ranging between 2.6 and 4.6 mm and in height between 0.4 and 3.9 mm was observed ⁽²⁸⁾ Lekovic also showed that, following tooth extraction, the rate of residual ridge resorption is related to the time extended since the tooth was removed. ⁽²⁹⁾

This concept is further assured by Schropp et al who evaluated the tissue changes after extraction of a premolar or molar in 46 patients in a 12-month period. The results demonstrated that major changes of an extraction site occurred during 1 year after tooth extraction. When examining the premolar area only, a loss of alveolar ridge width of 45% was reported, of which about third occurred in the first 12 weeks. ⁽³⁰⁾ Although, A recently published systematic review reported a greater horizontal alveolar ridge reduction than vertical bone loss at 6 months. ⁽³¹⁾

Also, Zaffe et al used dissolution of aqueous nanocrystalline hydroxyapatite and applied it to post-extractive sites. They showed that the use of nanocrystalline hydroxyapatite as bone regenerating material leads to the formation of a highly suitable implant support consisting exclusively of bone in less than 12 months, i.e. in a remarkably short time. ⁽³²⁾

The result of the present study is also consistent with an article published by Araujo et al. who demonstrated that the placement of a biomaterial in an extraction socket will enhance bone modeling and compensate the marginal ridge contraction. ⁽³³⁾

Another study recommends that the use of nano-bone in extractions operations and bone fractures lead to speed healing. This study was carried out on dogs who were treated with nano hydroxyapatite to seal the socket after simple atraumatic extraction of lower 2nd premolar. It was concluded that nano-bone graft accelerates the formation of bone filling the extracted bony socket and preserved three dimensions of the extracted bony socket. ⁽³⁴⁾

On the other hand, one study has shown that ridge preservation does not completely prevent bone loss, it aids in reducing the extent of that loss. ⁽³⁵⁾

CONCLUSION

The outcome of the present study concluded that, after atraumatic extraction of the premolar tooth, using nano hydroxyapatite together with collagen membrane to seal the socket accelerates the formation of bone filling in the extracted bony socket, increasing its density and preserving its three dimensions.

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الأزهر

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تقييم الحفاظ على تجويف السنة بعد خلعها باستخدام عظم النانو (هيدروكسي-اباتيت) بالإضافة إلى استخدام غشاء الكولاجين

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الملخص:

الهدف: تهدف هذه الدراسة الى تقييم الحفاظ على تجويف السنة بعد خلعها باستخدام عظم النانو (هيدروكسي-اباتيت) الاصطناعي، بالإضافة إلى استخدام غشاء الكولاجين.

المواد والأساليب: تم اختيار 14 مريض في هذه الدراسة من عيادة جراحة الفم والوجه والفكين بكلية طب الأسنان، جامعة الأزهر، القاهرة، بنين. وقد تم خلع الضرس الموجود في الصَّاحِكة السُّفْلِيَّة لجميع المرضى المشاركين. ثم تم تقسيم المرضى المشاركين إلى مجموعتين. المجموعة الأولى والمكونة من 7 تجاويف حيث تم استخدام عظم النانو، والمجموعة الثانية مكونة من 7 تجاويف أيضا تم استخدامهم كمجموعة مقارنة. تم إجراء عملية خلع الصَّاحِكة السفلية لجميع المرضى المشاركين. ثم استخدام معجون العظم النانو في داخل تجويف الضرس. يلي ذلك تغطية إضافية للموقع الجراحي عن طريق غشاء الكولاجين. تم المتابعة بعد 3 و 6 أشهر من العملية وأجريت فحوصات باستخدام الأشعة المقطعية المحروية بالحاسوب في كل زيارة متابعة لتقييم كثافة العظام وأبعاد تجويف الضرس. تم تسجيل جميع القراءات و تحليلها احصائيا.

النتائج: أظهرت نتائج الدراسة أن هناك فروق ذات دلالة إحصائية فيما يتعلق بأبعاد تجويف الضرس وكثافة العظام في زيارات المتابعة المختلفة في مجموعة الدراسة.

الخلاصة: استخدام معجون العظم النانو بالإضافة الى غشاء الكولاجين يسرع من تكوين العظم في داخل تجويف الضرس بعد خلعه

الكلمات المفتاحية: الحفاظ على تجويف السنة بعد خلعها، عظم النانو (هيدروكسي-اباتيت)، غشاء الكولاجين، الأشعة المقطعية المحروية بالحاسوب ، مقاسات ثلاثية الأبعاد.