Original Research Article

Radiological measurement of bone density to assess the efficiency of bone graft

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Abstract

Introduction: The ideal bone graft substitute should provide osteogenetic cells to facilitate bone regeneration, osteoinductive factors to induce bone formation and an osteoconductive matrix to directly stimulate bone deposition. The present study was conducted to radiologically assess the regenerative potential of hydroxyapatite with collagen and to evaluate the clinical usefulness of these materials to enhance bone healing.

Materials and methods: Orthopentomogram (OPG) were taken after extraction in the control group and after extraction but before graft placement in study group and post operatively after 8 weeks. Each image was analyzed for bone density of the post-extraction sockets through 'densitometric analysis' software in the OPG program. Chi-square test was applied to find the correlation.

Results: Post-operative mean measurement for study group was 108.72±22.54 after extraction and was 136.59±23.20 after 8 weeks with significant p value (0.00). The value for control group was 119.69±18.41 after extraction and was 121.39±14.21 after 8 weeks with insignificant p value (1.96).

Conclusion: Grafting of the surgical site results in faster regeneration of tissue and computer assisted image analysis software is an important aid in assessing the bone density changes at the surgical site.

Key words

Densitometric analysis, Graft, Hydroxyapatite, Collagen.

Introduction

The ideal bone graft substitute should provide osteogenetic cells to facilitate bone regeneration, osteoinductive factors to induce bone formation and an osteoconductive matrix to directly stimulate bone deposition. Osteoconductive materials have no capability to induce formation and they merely provide an interconnected biocompatible scaffold, which local osseous tissue can utilize to regenerate living bone. Osteoinductive materials facilitate new bone formation by allowing cells in the local environment to undergo phenotypic conversion to osteoprogenitor cell types capable of formation of bone. Osteogenic is a graft material that has the inherent capacity to form bone, which implies that it has cells such as osteoblasts or osteocytes, capable of producing bone [1]. Skeletal bones comprise mainly of collagen and carbonate substituted hydroxyapatite, both osteoconductive components [2]. Hydroxyapatite acts as a scaffold for bony in growth and gradually replaced by new bone. It is unique biocompatible ceramic substance that is a useful and versatile biomaterial [3]. Thus, an implant manufactured from such components is likely to behave in a same manner, and to be more useful than a monolithic device. Indeed, both collagen type I and hydroxyapatite were found to enhance osteoblast differentiation but combined together, they were shown to accelerate Osteogenesis [2]. The present study was conducted to radiologically assess the regenerative potential of hydroxyapatite with Collagen and to evaluate the clinical usefulness of these materials to enhance bone healing.

Material and methods

The study was conducted in the Department of Radiology in association with dental surgeon who placed graft comprised of Hydroxyapatite with collagen in III molar extraction site. 20 dental patients were randomly selected for the study that went surgery for impacted III molar. The study sample were divided into two groups; group I comprised of 10 patients in which graft (Hydroxyapatite with collagen) was placed after extraction of impacted III molar and group II was control group which comprised of 10 patients in which no grafts was placed after III molar extraction. Patients were informed about the procedure and consent was obtained. All surgeries were performed under local anesthesia by same dental surgeon. Bone was removed where required on proximal aspects of the tooth, tooth elevation; crown removal and or root division and elevation were carried out as and when required. After removal of the tooth the surgical field was thoroughly rinsed with sterile 0.9% saline. Orthopentomogram (OPG) was taken after extraction in the control group and after extraction but before graft placement in study group and post operatively after 8 weeks. Obtained OPGs were digitized with a scanner and then saved in the TIFF format. Each image was analyzed for bone density of the post-extraction sockets which was measured at three random sites through ‘densitometric analysis’ software (Kodak 8000C Digital Panoramic System, Eastman Kodak Company) in the OPG program and an average value was recorded. The data were collected and entered into a Microsoft Excel Worksheet and analyzed using SPSS (version 7.5) statistical package. Chi-square test was applied to find the correlation**.**

Results

Bone density was measured from scanned Orthopentomogram (OPG) (in pixels). Post-operative mean measurement for study group was 108.72±22.54 after extraction and was 136.59±23.20 after 8 weeks with significant p value (0.00). The value for control group was 119.69±18.41 after extraction and was 121.39±14.21 after 8 weeks with insignificant p value (1.96) as per **Table - 1**.

Table - 1: Mean bone density on different days.

Group	**Duration (Mean±Standard deviation)**		**p-value**
	After extraction	**After 8 weeks**	
I (Study group, Graft)	108.72±22.54	136.59±23.20	0.00
II (Contol)	119.69±18.41	121.39±14.21	1.96

Discussion

Bone injury requires bone grafting where bone is taken from a donor site and implanted into the patient. Reconstruction of missing or damaged bone tissue presents a major surgical challenge [4]. Bone is a typical nanocomposite composed of nonstoichiometric carbonate containing hydroxyapatite nanocrystals as main inorganic phase and type-I collagen molecules as main organic phase. Bone as a hard material, nanocomposite of hydroxyapatite and collagen apparently behaves as a single material macroscopically; that is, they retain the viscoelasticity of collagen and hardness of hydroxyapatite [5].

Collagen, as a natural polymer, is increasingly being used as a device material in tissue engineering and repair. Collagen is easily degraded and resorbed by the body and allows good attachment to cells. However, its mechanical properties are relatively low in comparison to bone and it is therefore is cross linked with hydroxyapatite for bone remodelling [2]. Hydroxyapatite is a substitute for autologous graft. Hydroxyapatite is available in various physical forms. Bone formation, graft incorporation varies with each. HA in ceramic and crystalline form is slow in resorption and bone formation, where as non ceramic, non crystalline form is fast in resorption and in bone formation. Collagen is added to hydroxyapatite to give mechanical strength [6].

Density is the degree of darkening of exposed and processed X-ray film, expressed as the logarithm of the opacity of a given area of the film. Radio-visiography has a program to measure bone density [3]. The measurements of density of the extraction socket revealed that bone deposition was at faster rate in extraction socket with graft placement as compared to control site. Kattimani VS, et al. [7] evaluated the efficacy of eggshell derived hydroxyapatite in the bone regeneration of human maxillary cystic bone defects secondary to cystic removal or apicoectomy and compare found that by the end of the 8th week, the defects grafted with EHA showed complete bone formation. Similarly Khalid I, et al. [8] and Panday V, et al. [9] also scanned Orthopentomogram (OPG) by using computer- assisted densitometric image analysis software and showed more density on the graft site. Bould M, et al. [10] assessed the accuracy and reproducibility of a digital image analyser and the human eye, in measuring radiographic dimensions and concluded that digital image analysis system is up to 20 times more accurate than the human eye. The other radiological imaging technologies and methods used for quantification of bone healing are dual energy X-ray absorptiometry, single energy X-ray absorptiometry, radiographic absorptometry, ultrasound and quantitative computed tomography. However, these techniques are costly and have radiation hazards except ultrasound [11].

Conclusion

Grafting of the surgical site results in faster regeneration of tissue and image analysis allow more accurate and reproducible measurement of bone density from standard follow-up radiographs. Thus, the present study found that computer assisted image analysis software is an important aid in assessing the bone density changes at the surgical site.

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