Use of Computer- Assisted Densitometric Image Analysis (CADIA) in Assessing Bone Density Changes in Extraction Socket

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Abstract

The present study was undertaken to evaluate the regeneration of bone in the extraction socket by using computer- assisted densitometric image analysis (CADIA) in 10 patients with bilateral symmetrical mandibular third molar impactions, after extraction. In one side hydroxyapatite (HA) was placed into the socket and on the other side no graft was placed. Standardized intraoral periapical radiograph (IOPA) and orthopantomograph (OPG) were taken, 15 days postoperatively, and at 3 and 6 months interval. These radiographs were scanned by using CADIA and images were compared, which showed more density on the graft side. The radiographic data were compared to clinical parameters. The results indicated that CADIA may be useful in assessing the bone density changes in an extraction socket.

Key words: Extraction socket, bone grafts, hydroxyapatite, density changes, CADIA.

Introduction

Assessing the changes in bone density after placing bone graft has been a challenging task. Lots of methods have been devised since ages (Table 1). The techniques mentioned are costly and have radiation hazards except ultrasound. [1]

For a reliable and predictable assessment of alveolar bone status Lang and Hill[1] and Payot et al.,[2] measured the alveolar bone density changes in the mandibular molars by means of Computer Assisted Photo Densitometry of standardized radiographs. Bragger et al., tested Computer Assisted Densitometric Image Analysis system (CADIA) clinically for its validity in quantitatively assessing a radiographic alveolar bone density.[3]

The purpose of the study was to test the applicability of CADIA for quantitative assessment of alveolar bone density in extraction socket after placing hydroxyapatite. Calciumhydroxyapatite-Beta tri-calcium phosphate granule is a biomaterial offering great potential for correction of maxillofacial defects.[4] We used bioceramic composite material which contains 90% hydroxyapatite and 10% beta tri-calcium phosphate (by AVANTI Laboratory, MED CAB) in granule form to fill the bony defect after surgical removal of impacted third molars.

Material and methods

In our study bilateral symmetrical mandibular third molar impacted cases were selected (Figure 1). The tooth was removed by first class lever principle with a regular dental elevator. The bone margins were filed and smoothened with a bone file. The wound was irrigated with an irrigating solution. Granules of hydroxyapatite were placed in one of the extracted socket till the level of the alveolar crest and care was taken not to compress the granules in the socket (Figure 2). The flap was approximated and sutured with 3-0 non absorbable black braided silk which served as an experimental site. The other extraction socket in the same patient which was left without any hydroxyapatite granules, served as a control site (Figure 3).[5]

Radiological assessment was done at various intervals[6] to assess the regeneration of bone. Post operative evaluation of all the subjects was done for a period of 6 months starting from the day of operation.

The following radiographs were taken

- Pre operative radiographs (Figure 4,5)
- Post operative (15 days) radiographs (Figure 6,7) after placement of graft
- Post operative radiographs after 3 month. (Figure 8,9)
- Post operative radiograph after 6 months (Figure 10,11)

Technique	Precision (%)	Accuracy (%)	Duration of test (min)	Radiation dose (µSV)
Dual energy X-ray absorptiometry	1-2	4-8	5	1
Single energy X-ray absorptiometry	1-2	2-5	4	<1
Radiographic absorptiometry	2	6	1-3	1
Quantitative computerized tomography	2-6	3-15	10-20	60-100
Ultrasound	2	-	10 sec	-

Table 1: Methods for assessing changes in bone density

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Sl.NO	Non Graft side	Graft side
1	70.10	89.25
2	76.30	80.10
3	90.20	89.05
4	76.10	82.35
5	81.20	92.35
6	86.20	85.05
7	82.30	84.10
8	75.40	76.25
9	75.15	80.15
10	81.05	84.20

Table 2: Three months postoperative CADIA values

Sl.NO	Non Graft side	Graft side
1	74.80	85.05
2	80.90	86.10
3	94.25	92.10
4	79.05	81.10
5	82.10	86.15
6	84.15	88.25
7	86.05	86.20
8	80.15	77.80
9	90.35	84.15
10	84.05	89.05

Table 3: Six months postoperative CADIA values

The images were imparted into a software based on Imaging Research INC ®. A template of the region of interest was made in the preoperative radiograph on the windows. Density values were recorded in grey levels from 0-255. The grey level values and the area of the region of interest were determined. The same template was used on the radiographs taken at 15 days post operatively, 3 months and 6 months post operatively by using the cursor. The average of the grey values were calculated for the radiographs of the graft site and compared with that of non graft site.[7,8]

Results

The intrabony component of the defects in the untreated sites (non grafted) seemed to be stable after a period of three months (mean CADIA value 79.4) (Table 2). Whereas in the treatment groups (grafted), a gain in density was found (mean CADIA value 84.28).

Six Month Postoperative CADIA values revealed (Table 3), a loss in bone density for the non grafted group (mean CADIA value 83.58), while grafted group revealed a gain in density (mean CADIA value 85.59). Differences in density were significant both between the nongrafted and grafted sites .

Discussion

The application of radiography in clinical trials has to deal with the fact that densitometric comparisons between serial radiographs will always give some false positive values due to methodological errors. Briefly, an image processing system was applied for the acquisition of digitized images (512×480 pixels). Grey level correction of images to be compared was performed using 5 reference windows on the images of the integrated step wedge. Within areas of interest which were defined in furcation areas, the grey levels of all 2×2 pixel areas were averaged. Average grey levels which changed more than 13 grey levels (5% from 256 available grey levels) were recorded. The area (mm^2) within a window undergoing density change was multiplied by the mean density change. This analysis was performed for positive and negative changes separately. The sum of the density changes represented the overall density change within each window (net CADIA value). [9]

The radiographic data presented in this report indicated healing within the alveolar bone tissues characterized by gain in radiographic bone height and density. The healing responses were influenced by the type of treatment rendered. The grafted sites demonstrated a higher bone density as demonstrated by grey levels, compared to controls. Analyses of the radiographic data from the untreated sites revealed a slowly continuing loss of bone height.

The physical principles of imaging systems must be adapted to reveal the diagnostic information hidden in a pattern or range of "densities" projected onto surrounding structures. Therefore, a radiographic evaluation of bone may need different conditions compared to e.g., imaging of caries lesions. In this study a new parameter (CADIA of crestal alveolar bone) was tested for its potential to reveal diagnostic information on the changes in ridge height following exodontia.

Computer-assisted densitometric image analysis (CADIA) was applied in order to quantify changes in density during the healing phase after tooth extraction. Region of interests

Figure 1: Intra oral view of bilateral symmetrical impaction.

Figure 2: Hydroxyapatite + Tricalcium phosphate granules placed in extraction socket on experimental site.

Figure 3: Control site with no graft

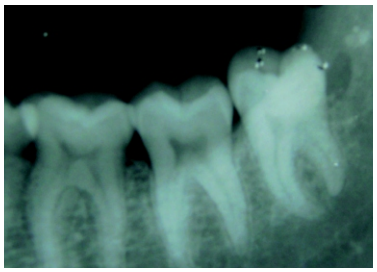

Figure 4: Pre operative radiograph of graft site

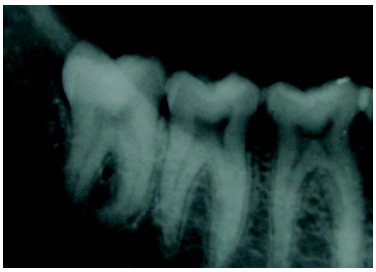

Figure 5: Pre operative radiograph of control (non graft) site

Figure 6: Post operative (15 days) radiograph of graft site

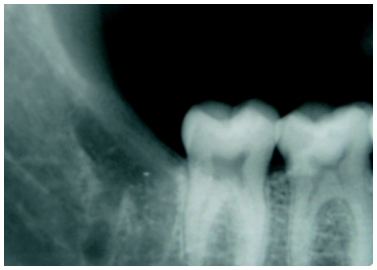

Figure 7: Post operative (15 days) radiograph of control (non graft) site

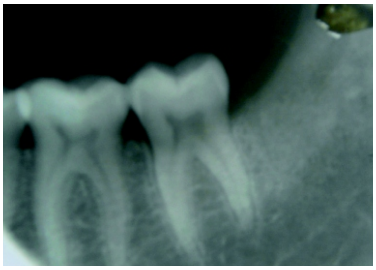

Figure 8: Post operative (3 months) radiograph of graft site

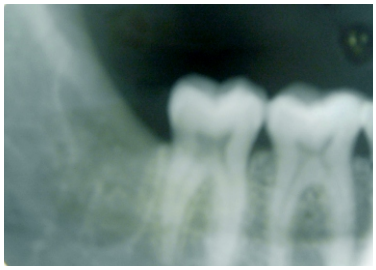

Figure 9: Post operative (3 months) radiograph of control (non graft) site

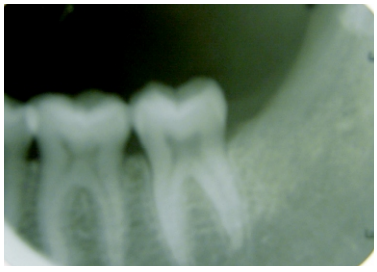

Figure 10: Post operative (6 months) radiograph of graft site

Figure 11: Post operative (6 months) radiograph of control (non graft) site

were also defined on crestal alveolar bone adjacent to the extraction wound.[10,11]

In the active group, 06/10 sites demonstrated increase in alveolar bone density between months 1 and 6 (mean CADIA value 85.59), whereas in the non grafted sites, there was demonstration of loss of density (mean CADIA value 83.58).

The study demonstrated that CADIA could be used to test the bone changes following bone augmentation procedures.

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