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ORIGINAL RESEARCH


# Evaluation of Spontaneous Bone Regeneration after Enucleation of Large Cysts of the Jaws using Radiographic Computed Software

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## ABSTRACT

**Introduction:** Spontaneous regeneration of bone is commonly seen in the small surgical defects caused by enucleation of cysts. However, in case of large surgical defects caused by the enucleation, spontaneous regeneration of bone is a rare phenomenon and it depends on factors, such as age of the patient, intact periosteum, and proper stabilization.

**Materials and methods:** The study included 16 patients, who reported to the department of oral and maxillofacial surgery with the complaint of pain and swelling in the jaws diagnosed as cyst. The sample included equal numbers of male and female subjects aged between 15 and 40 years. Panoramic radiographs were taken pre- and postoperatively on day 2 of the enucleation.

The dimensions of the cyst were evaluated on the radiograph according to the proforma.

Subsequent radiographs were taken at regular intervals of 1.5, 3, and 6 months using standard parameters and were analyzed using MCID™ analysis software of imaging research.

**Results:** Mean reduction was seen in up to 39 and 60% in the cystic cavity size and increase in the mean density up to 59 and 90.2% at 3 and 6 months intervals respectively.

**Conclusion:** Spontaneous bone regeneration was seen even after primary closure of the large cystic defect without the need for placement of foreign substances or grafts and it also eliminated the complications resulting from placement of foreign substance. Further studies are required in a larger sample with longer follow-up durations to confirm the outcome of the present work for the benefit of patients.

**Clinical significance:** The present study depicted that spontaneous bone regeneration can occur with accepted results after simple enucleation of jaw cyst without the aid of any graft material. Hence, simple enucleation may be considered as a first line of treatment modality for cystic lesion of the jaws. This simplifies the surgical procedure, decreases the economic and biologic costs, and reduces the risk of postoperative complications. Follow-up is necessary along with patient's compliance for the success of treatment.

**Keywords:** Bone regeneration, Cyst enucleation, MCID, Orthopantomogram, Radiographic evaluation.

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## INTRODUCTION

Spontaneous bone regeneration of a large defect is an unexpected phenomenon, but in the presence of intact periosteum as a source of osteogenic tissue, mandibular stabilization, and young age of the patients, spontaneous bone regeneration of mandibular defect can occur.[1] The small cysts in the jaws are managed surgically by enucleation and primary closure, but the large cysts are usually managed by secondary closure. The primary closure for a large cyst is a much debated topic among surgeons. Large surgical defect caused after enucleation of the large cyst can be filled by spontaneous regeneration of bone after the primary closure, but it depends on various factors, such as age of the patient, intact adjacent periosteum, and proper immobilization. To promote healing of large residual cyst cavities by primary intention, an attempt is often made to reduce the size of

the cavity or to reduce the volume of blood clot. The basic potential of a cystic cavity to regenerate is well known, and it is the underlying philosophy of marsupialization.[1,2] However, bone regeneration after enucleation and primary closure take place in a more protected environment, and therefore faster.[1]

The use of autogenous grafts or implant materials in the presence of large cystic cavities has its own limitations, namely, transmission of disease from the donor to the recipient, contaminated specimen causing infection at the recipient site, host incompatibility, ineffective usefulness in surgical treatment, need for a secondary surgical donor site, increased postoperative morbidity, increased surgical time, and inadequate amount of autogenous bone available can lead to graft failure with exudation and exfoliation of the grafted material necessitating a secondary procedure and hence a delay in bone healing.[1]

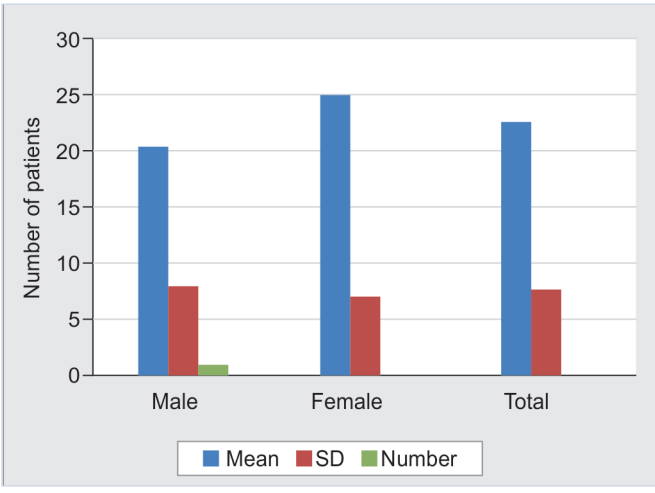
So it is important to assess the qualitative and quantitative aspects of regenerated bone, which can be done by invasive and noninvasive techniques. Radiography is the major non-surgical method for detecting bone formation in a healing osseous wound. It is a more useful method than histological examination in clinical situations because of its speed, continuity of measurement, and its relative safety due to its noninvasive nature.

## MATERIALS AND METHODS

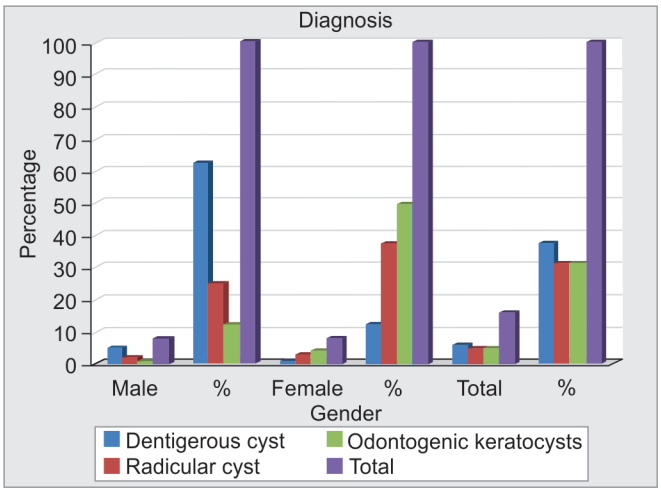
The present study included 16 cases who reported to the Department of Oral and Maxillofacial Surgery, Bapuji Dental College & Hospital, Davangere, between October 2004 and August 2006, with complaint of pain and swelling. The sample included 8 males and 8 females patients, aged between 15 and 40 years (Graph 1). A thorough medical examination was carried out (Fig. 1). Approval was obtained from the ethics committee of Bapuji Dental College & Hospital, Davangere, and informed consent was obtained from each patient before starting the study. In all the cases included in the study, the diagnosis of the cyst was confirmed by aspiration biopsy, protein estimation, and radiographs. In cases that were negative for aspiration, these were confirmed by incision biopsy.

**Fig. 1:** Preoperative patient frontal view

Orthopantomograph and occlusal radiographs were taken preoperatively in all the cases for mandibular and maxillary lesions respectively, using standard parameters (Figs 2 and 3). The location and the type of the lesion were as seen in Graph 2. Depending on the size of the cyst, additional radiographs like paranasal view (PNS) or computed tomography (CT) scan were taken in three cases. Informed consent was taken from the patients for the study and the surgical procedure. Enucleation was done under general anesthesia and the cyst was enucleated in toto whenever possible (Figs 4 and 5). The cyst was curetted to macroscopically remove all residual fragments and to reduce the risk of recurrence. Areas where vital roots of neighboring teeth were involved were spared. In all the cases, primary closure was performed with 3–0 vicryl (NW2472) sutures. The sutures were removed between the 7th and 10th day postoperatively.




**Graph 1:** Distribution of age and sex




**Graph 2:** Distribution of study subjects according to types of cysts

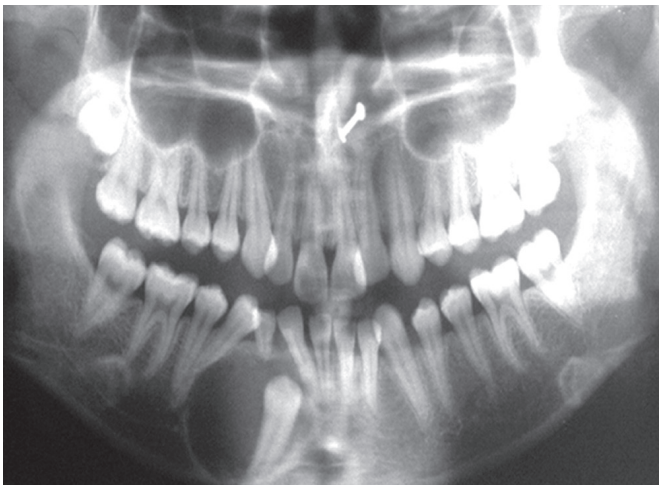


**Fig. 2:** Preoperative occlusal radiograph

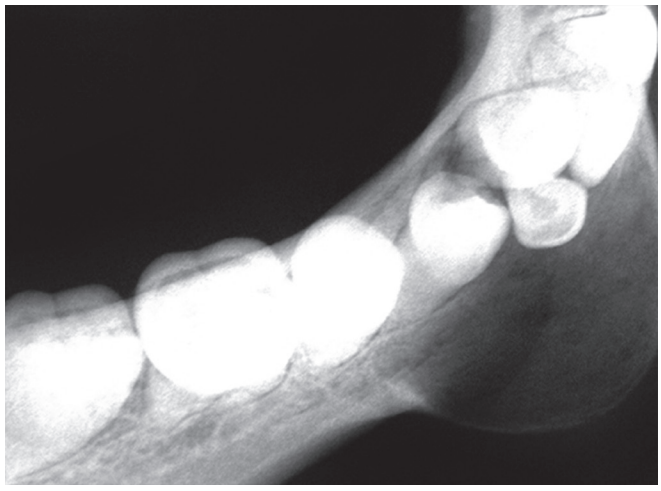


**Fig. 3:** Preoperative orthopantomograph

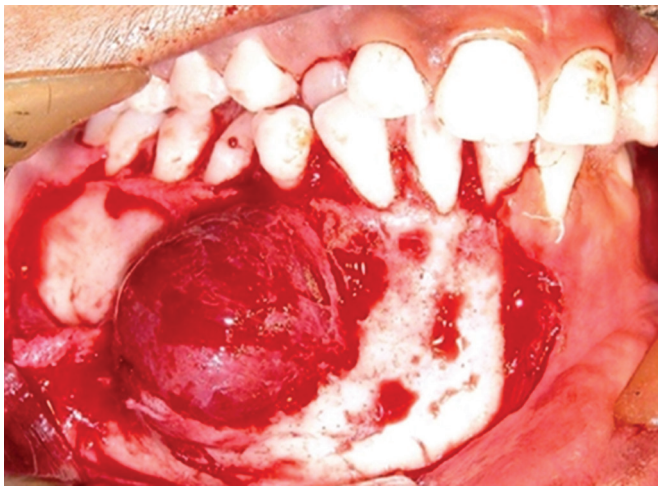


**Fig. 4:** Intraoral surgical exposure of cyst

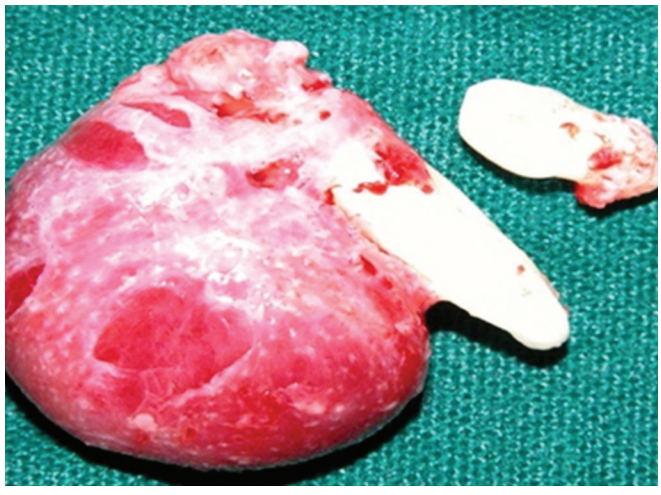


**Fig. 5:** Specimen of cyst after enucleation

All patients were under antibiotics for a minimum period of 5 days postoperatively, patients were advised to maintain good oral hygiene and oral rinses using 2% chlorhexidine gluconate mouth rinses (3–4 times daily). Prophylactic intermaxillary fixation along with judicious use of nasogastric tube to avoid food debris entrapment at surgical site was performed. Some cases had reported with minor postsurgical complications; however, after 10 days, all the cases had uneventful healing with primary closure.

The dimensions of the cyst were evaluated on panoramic radiograph just taken before surgical treatment. The Orthopantomograms (OPGs) were taken using Gendex Orthoralic X 9200 machine with an exposure time of 12 seconds, total cycle 24 seconds, and a magnification of 1.25. Occlusal radiographs were taken using Exploir X65 KV exposure time 0.9 seconds Mandible and 0.8 seconds Maxilla. Postoperative radiographs were taken 2 days immediately after surgery, and subsequently at the end of 1.5-, 3-, and 6-month intervals using the same standard parameters. All radiographs were scanned using HP (Hewlett Packard) 1410 series scanner. The images were converted to TIFF format of 8 bit gray scale with 150 resolution using Adobe Photoshop CS2 software. The obtained TIFF formal images were cropped and adjusted to specific dimensions (1024 × 764). The dimension of the cyst were carried in both x-axis and y-axis using MCID™ analysis software of imaging research (Fig. 6). The TIFF

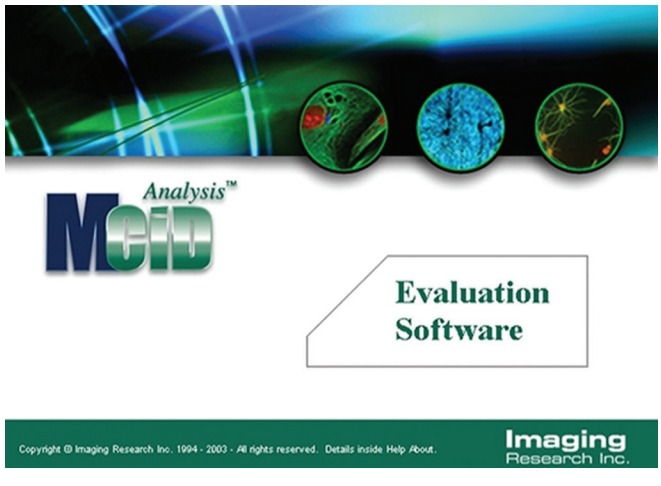



**Fig. 6:** MCID™ analysis software of imaging research

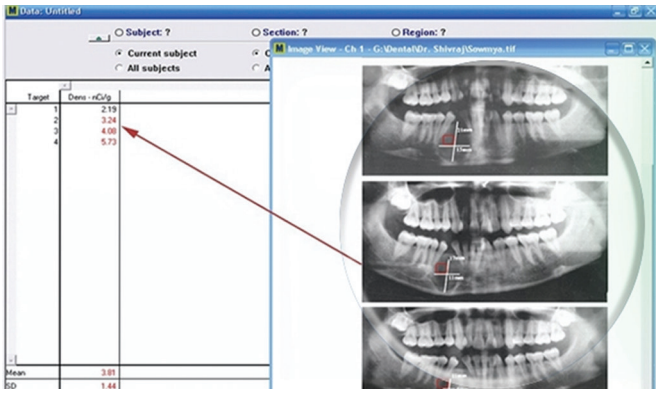


**Fig. 7:** Calibration measurement of density in terms of nCi/g using MCID software

formatted images were retrieved. Calibration measurement of density measured in terms of nCi/g (Fig. 7). The subsequent reduction in size of the lesion during the postoperative healing periods were analyzed and tabulated.

The data were tabulated and electronically stored. Paired and unpaired t test, as appropriate, was used to assess the significance of difference. The level of significance less than 0.05 ($p<0.05$) was considered as significant. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 21.0.

## RESULTS

The analysis involved a total of 16 patients: 13 (cyst in the mandible) and 3 (cyst in the maxilla). In all the cases, there was healing without any complications. Gradual increase in the density and reduction in the cavity size was observed in both maxilla and mandible on the radiographs.

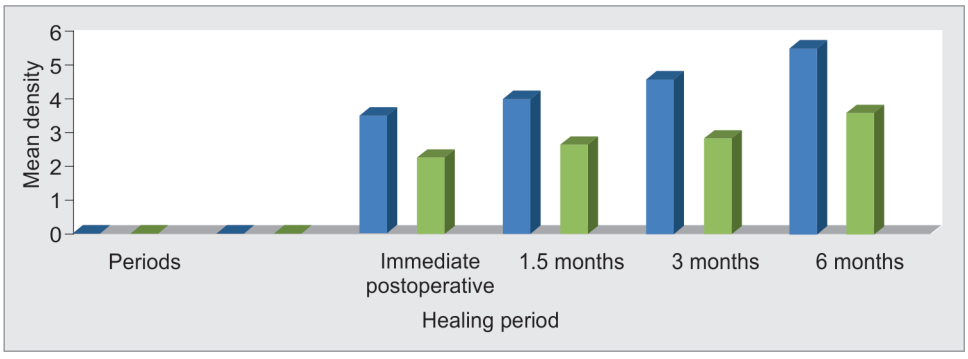
A computerized analysis of the postoperative radiographs using MICD® analysis software showed a mean increase in bone density of the residual cavities, which was 3.2889, 3.7540, 4.2693, and 5.1644 immediately postoperative, 1.5, 3 and 6 months respectively. On comparing the mean value of each interval between the immediate postop with 1.5 months, immediate postoperative with 3 months, and immediate postoperative with 6, 1.5 to 3 months, 1.5 to 6 months, and 3 to 6 months, a statistical significant increase in mean density with p value of 0.0003, 0.0001, 0.000, 0.0018, 0.0001, and 0.0002 respectively, was observed (Table 1).

The mandibular cavities showed the higher density values as compared to the maxilla. Mean increase in density values of 3.5231, 4.0054, 4.5956, and 5.5246 at immediate postoperative, 1.5, 3, and 6 months respectively, in case of mandibular lesions and 2.274, 2.6646, 2.855, and 3.6033 at immediate postoperative, 1.5, 3, and 6 months respectively, in maxillary cystic lesions was observed (Graph 3).

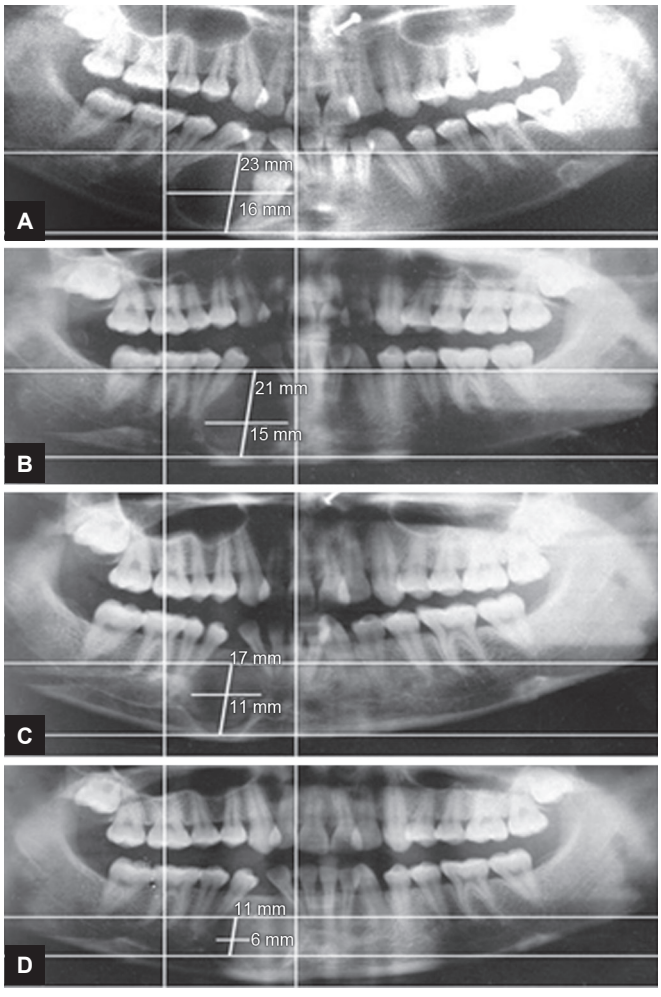
**Table 1:** Comparison of bone density (nCi/g) by conventional radiographic method at different postoperative periods

| *Periods* | *Mean* | *Standard deviation (SD)* | *Mean difference* | *SD difference* | *t-value* | *p-value* | *Significance* |
|---|---|---|---|---|---|---|---|
| Immediate postoperative | 3.2889 | 4.9771 | | | | | |
| 1.5 months | 3.7540 | 5.0527 | 0.4651 | 0.4041 | 4.6037 | 0.0003 | S |
| Immediate postoperative | 3.2889 | 4.9771 | | | | | |
| 3 months | 4.2693 | 5.4922 | 0.9804 | 0.7316 | 5.3603 | 0.0001 | S |
| Immediate postoperative | 3.2889 | 4.9771 | | | | | |
| 6 months | 5.1644 | 5.7782 | 1.8755 | 1.2625 | 5.9423 | 0.0000 | S |
| 1.5 months | 3.7540 | 5.0527 | | | | | |
| 3 months | 4.2693 | 5.4922 | 0.5153 | 0.5432 | 3.7942 | 0.0018 | S |
| 1.5 months | 3.7540 | 5.0527 | | | | | |
| 6 months | 5.1644 | 5.7782 | 1.4104 | 1.0490 | 5.3782 | 0.0001 | S |
| 3 months | 4.2693 | 5.4922 | | | | | |
| 6 months | 5.1644 | 5.7782 | 0.8951 | 0.7309 | 4.8988 | 0.0002 | S |

S: Singnificant




**Graph 3:** Comparison of mandible and maxilla with respect to density values in postoperative healing periods




**Figs 8A to D:** Evaluation for reduction of size of the cystic cavity: (A) Preoperative OPG; (B) 1.5 months following OPG; and (C) 3-month postoperative OPG; and (D) 6-month postoperative OPG

The mean reductions in size of the residual cystic cavities at immediate postoperative, 1.5, 3, and 6 months are 30.125, 25.4375, 20.3125, and 12.3750 along x-axis and 23.5625, 20.25, 15.1125, and 10.625 along y-axis was observed on computer analysis (Figs 8A to D) (Table 2).

On analysis of the values, it was apparent that there was a significant increase in density and reduction in the cystic cavity size.

## DISCUSSION

The concept of spontaneous bone regeneration is an accepted fact in cases of small cysts, but some difference of opinion exists in treating large cyst cavities by secondary healing. Many authors suggest using the filler materials to achieve primary bone healing in a defect larger than 3 cm in diameter.[3] The present study was designed to analyze the spontaneous bone regeneration in the large cysts ranging from 3 to 10 cm in dimensions. The spontaneous regeneration of bone in the cyst cavity was analyzed in relation to gradual increase in density and reduction of the size, noninvasively by radiographs using MCID Software. In the present study, there was statistically significant increase in the density and reduction in the size of the cavity observed as compared to immediately after the surgery without use of any filler material. The increase in the density was significant at the 3rd- and 6th-month periods, which was comparable to the previous study done by Lipa Bodner in the comparative study between demineralized freeze-dried bone allograft (DFDBA) and gel foam as filler after cyst enucleation (3 cm) reported that both the groups reached their maximum density at 12 months and plateaued at 24 months postoperative, whereas the present study showed a steady increase in density to about 90.8% at 6 months.[4] This rate of increase in density may be due to nonplacement of the filler material.

But regarding the use of DFDBA, Robert Marx states that there are about four potential disadvantages of: (1) Transmission of disease from donor to recipient, (2) contaminated specimen causing infection at the recipient site, (3) host incompatibility, and (4) ineffective usefulness in surgical treatment.[5]

The radiographic evaluation in comparison with computed tomography is not a precise tool to assess reduction in cystic cavity and their healing process, but with assistance of software analysis, the sensitivity of the study is enhanced, and reasonably brings down the cost and radiation exposure in special imaging techniques.

**Table 2:** Comparison of size of the residual cavity by conventional radiographic method at different postoperative periods

| *Periods* | *Mean* | *Standard deviation (SD)* | *Mean difference* | *SD difference* | *t-value* | *p-value* | *Significance* |
|---|---|---|---|---|---|---|---|
| Immediate postoperative | 30.1250 | 20.2316 | | | | | |
| 1.5 months | 25.4375 | 18.8820 | 4.6875 | 2.1515 | 8.7146 | 0.0000 | S |
| Immediate postoperative | 30.1250 | 20.2316 | | | | | |
| 3 months | 20.3125 | 17.5184 | 9.8125 | 4.0203 | 9.7630 | 0.0000 | S |
| Immediate postoperative | 30.1250 | 20.2316 | | | | | |
| 6 months | 12.3750 | 10.9598 | 17.7500 | 10.2404 | 6.9333 | 0.0000 | S |
| 1.5 months | 25.4375 | 18.8820 | | | | | |
| 3 months | 20.3125 | 17.5184 | 5.1250 | 2.1564 | 9.5066 | 0.0000 | S |
| 1.5 months | 25.4375 | 18.8820 | | | | | |
| 6 months | 12.3750 | 10.9598 | 13.0625 | 8.6446 | 6.0442 | 0.0000 | S |
| 3 months | 20.3125 | 17.5184 | | | | | |
| 6 months | 12.3750 | 10.9598 | 7.9375 | 7.3072 | 4.3450 | 0.0006 | S |

**Table 3:** Comparison of different postoperative period's length along y-axis in mm by conventional radiographic evaluation

| *Periods* | *Mean* | *Standard deviation (SD)* | *Mean difference* | *SD difference* | *t-value* | *p-value* | *Significance* |
|---|---|---|---|---|---|---|---|
| Immediate postoperative | 23.5625 | 10.0397 | | | | | |
| 1.5 months | 20.2500 | 9.9298 | 3.3125 | 2.3866 | 5.5518 | 0.0001 | S |
| Immediate postoperative | 23.5625 | 10.0397 | | | | | |
| 3 months | 15.8125 | 9.3610 | 7.7500 | 2.9777 | 10.4107 | 0.0000 | S |
| Immediate postoperative | 23.5625 | 10.0397 | | | | | |
| 6 months | 10.6250 | 7.8814 | 12.9375 | 5.1051 | 10.1368 | 0.0000 | S |
| 1.5 months | 20.2500 | 9.9298 | | | | | |
| 3 months | 15.8125 | 9.3610 | 4.4375 | 2.0646 | 8.5974 | 0.0000 | S |
| 1.5 months | 20.2500 | 9.9298 | | | | | |
| 6 months | 10.6250 | 7.8814 | 9.6250 | 3.9137 | 9.8374 | 0.0000 | S |
| 3 months | 15.8125 | 9.3610 | | | | | |
| 6 months | 10.6250 | 7.8814 | 5.1875 | 2.8570 | 7.2628 | 0.0000 | S |

S: Singnificant

Kawahi et al.[6] in their retrospective review of radiographic findings after removal of benign jaw cysts, categorized the site margins and interior contents into four groups: Unchanged, ground glass, spiculed, and trabecular. The "unchanged" category was seen in high percentage (68%) in the first month.[6] Our findings of initial calcification confirmed by the density analysis in radiographs were evident at 1.5 months (Table 1). The observation made in the second and 3rd months after surgery, 88% revealed alterations of the site margin, indicating radiographic alteration detectable between second and 3rd months.[6] The present study had shown more calcification process during the period between 2 to 4 months post operatively.

The interior sites observed more than 3 months after surgery, 97% were classified as "spiculed" or "trabecular" indicating apparent osteogenic changes. This suggests that bone regeneration and remodeling at the site will occur 4 months or more after surgery.[6-10]

These radiographic findings showing progression of ossification was similar to our findings, which had shown a consistent decrease in the cystic size and gradual increase in the opacity demonstrated by the densitometer (Tables 1 to 3).

## CONCLUSION

The treatment of choice for majority of benign cysts in the jaws is either enucleation or marsupialization. In the cases treated by enucleation, the cavity is filled with blood clot and secondary bone healing occurs over a period of time. Although this type is well accepted for some small cyst cavities less than 2 to 3 cm, there are few studies that are in favor of using bone grafts after enucleation, with autogenous, allograft, or alloplastic material.[11-15]

Spontaneous bone regeneration of large defects is an unexpected phenomenon, but in the presence of intact periosteum as a source of osteogenic tissue, mandibular stabilization, and young age of the patients, spontaneous bone regeneration of mandibular defects can occur.[16-18]

The spontaneous bone regeneration in our case studies had a cyst size ranging from 3 to 10 cm, mean size being 4.8 cm. All were treated by enucleation and left for spontaneous bone healing. This avoids second donor-site morbidity, reduces the surgical time, length of the hospital stay, chances of graft rejection, and wound infection as well as cut down on the cost factor for the patient.[14-20]

In the present study, we did not encounter any complication except for pain for duration of 2 weeks in 3 patients and parasthesia for 3 months in 6 cases, which was partly attributed to the use of Carnoy's solution. The pain was successfully managed by routine analgesic therapy (500 mg Paracetamol three times a day for three day). The study results were more than satisfactory in forms of reduction in cavity size. A mean reduction of 39% of cystic cavity noted at 3 months and 62% reduction noted at 6 months with a mean increase of density of 52% at 3 months and 90.8% increase in density within 6 months, but a greater number of cases and longer period of follow-up is suggested.

## REFERENCES


1. Chiapasco M, Rossi A, Motta JJ, Crescentini M, Jomes J. Spontaneous bone regeneration after enucleation of large mandibular cyst: radiographic computed analysis of 27 consecutive cases. J Oral Maxillofac Surg 2000 Sep;58(9):942-948.
2. Bodner L, Bar-Ziv J. Characteristics of bone formation following marsupialization of jaw cysts. Dentomaxillofac Radiol 1998 May;27(3):166-171.
3. Spengos NM. Irradiated allogenic bone grafts in the treatment of odontogenic cysts. J Oral Surg 1974 Sep;32(9): 674-678.
4. Bodner L. Effect of decalcified freeze – dried bone allograft on healing of jaw defects after cyst enucleation. J Oral Maxillofac Surg 1996 Nov;54(11):1282-1286.
5. Marx RE, Kline SN, Johnson RP, Malinin TI, Matthews JG 2nd, Gambill V. The use of freeze dried allogenic bone in oral and maxillofacial surgery. J Oral Surg 1981 Apr;39(4): 264-274.
6. Kawahi T, Murakami S, Hiranuma H, Osaka SM. Healing after removal of benign cysts and tumors of the jaw. A radiologic

appraisal. Oral Surg Oral Med Oral Pathol Oral Radial Endod 1995 Apr;79(4):517-525.

7. Hjorting-Hansen J, Andreasen JO. Incomplete bone healing of experimental cavities in dog mandible. Br J Oral Maxillofac Surg 1971 Jul;9(1):33-40.
8. Richter M, Laurent F, Chausse JM. Homologous Cancellous bone grafts for large jaw defects caused by bone cysts. J Oral Maxillofac Surg 1986 Jun;44(6):447-453.
9. Yih YW, Morita V. A modified technique for obliteration of large bony defects after cystectomy. J Oral Maxillofac Surg 1991 Jul;49(7):689-692.
10. Rockwood CA Jr, Green PD, Buccholz RW. Rockwood and Green's fractures in adults. 3rd ed. Philadelphia (PA): JB Lipponcott Company; 1991. p. 187-194.
11. Shear M. Cysts of the oral regions. 3rd ed. Oxford: Wright; 1992. p. 292.
12. Mitchell R. An evaluation of bone healing in cavities in the jaws implanted with a collagen matrix. Br J Oral and Maxillofac Surg 1992 Jun;30(3):180-182.
13. Bodner L, Bar-Ziv J, Kaffe I. CT of cystic jaw lesions. J Comput Assist Tomogr 1994 Jan-Feb;18(1):22-26.
14. Reynolds AM, Bowers MG. Fate of deminirilised freeze dried bone allograft in human intrabony defects. J Perirodontol 1996 Feb;67(2):150-157.
15. Santamari J, Garcia AM, Devicent JV, Landa S, Lopez-Arranz JS. Bone regeneration after redicular cyst removal with and without guided bone regeneration. Int J Oral Maxillofac Surg 1998 Apr;27(2):118-120.
16. Chan C, Thompson I, Robinson P, Wilson J, Hench L. Evaluation of bioglass/dextran composite as a bone graft substitute. Int J Oral Maxillofac Surg 2002 Feb;31(1):73-79.
17. Oyama T, Nishimoto S, Tsugwa T, Shimizu F. Efficacy of platelet-rich plasma in alveolar bone grafting. J Oral Maxillofac Surg 2004 May;62(5):555-558.
18. Chui BH, Zhu SJ, Kim BY, Huh JY, Lee SH, Jung JH. Effect of platelet-rich plasma (PRP) concentration on viability and proliferation of alveolar bone cells: an *in vitro* study. Int J Oral Maxillofac Surg 2005 Jun;34(4):420-424.
19. Rimondini L, Aldini NN, Fini M, Guzzardell G, Tschon M, Giardino R. *In vivo* experimental study on bone regeneration in critical bone defects using an injectable biodegradable PLA/PGA copolymer. Oral Surg Oral Med Oral Pathol Oral Radial Endod 2005 Feb;99(2):148-154.
20. Pradel W, Eckelt U, Lauer G. Bone regeneration after enucleation of mandibular cysts: comparing autogenous grafts from tissue – engineered bone and iliac bone. Oral Surg Oral Med Oral Pathol Oral Radial Endod 2006 Mar;101(3):285-290.