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RESEARCH ARTICLE

EVALUATION OF CORALLINE POROUS HYDROXYAPATITE AS A BONE SUBSTITUTE - A CLINICAL, RADIOGRAPHIC AND SURGICAL RE-ENTRY ANALYSIS

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ABSTRACT

Purpose: Intrabony defects pose a clinical challenge in treatment practice. Various regenerative techniques have been proposed for the treatment of residual defects. In particular, for intrabony defects or angular defects with a ≥ 3 mm of intrabony component, osseous grafts have been widely used. They have shown bone fill in the deepest portion of the defect. The purpose of this study is to evaluate coralline porous hydroxyapatite as a bone substitute in treatment of such defects.

Methods: This present article reports a case series demonstrating the clinical and radiographic response to 3 different surgical procedures in the management of intrabony defects namely - open flap debridement (OFD), open flap debridement in conjunction with bone substitute coralline porous hydroxyapatite (OFD+CHA) and open flap debridement and placement of coralline porous hydroxyapatite and a resorbable collagen membrane (OFD+CHA+MEM). This follow-up also includes a surgical re-entry in the OFD+CHA+MEM site.

Results: OFD, OFD+CHA, OFD+CHA+MEM, showed gain in clinical attachement and recession of 3mm and 1mm, 4mm and 1mm, 3mm and 0mm respectively. The radiographic bonefill as assessed by image analysis was seen to be 0.3mm, 6.9mm and 6.9mm for OFD, OFD+CHA & OFD+CHA+MEM respectively. On surgical re-entry at OFD+CHA+MEM, the wound site showed remarkable healing, the membrane had undergone complete resorption; the graft particles showed no mobility and were incorporated in the surrounding alveolar bone.

Conclusion: To conclude, the 3 treatment modalities yielded results in accordance with the previous studies. The surgical re-entry procedure also revealed incorporation of graft particles in the surrounding healthy bone. Also the graft particles were stable and did not show any mobility. There was evidence of new bone formation at the base of the defect. These observations suggest that the coralline porous hydroxyapatite granules are compatible with the surrounding bone.

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INTRODUCTION

Inflammatory periodontal disease results in destruction of the periodontium. The regeneration of this destroyed periodontium remains the elusive goal for periodontal treatment (Periodontal Regeneration, 2005). As the periodontal lesion advances, the alveolar crest undergoes resorption resulting in opening up of cancellous spaces. Compensatory deposition of bone occurs at sites distant from the inflammation, resulting in osseous defects of varied morphology; one such type being the intrabony defect.

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The intrabony defects have been classified as marginal defects, intra-alveolar defects, furcation defects and perforations. Intrabony defects pose a clinical challenge in treatment practice. These defects may be treated either by less accepted & compensatory resective techniques or more promising regenerative techniques. Various regenerative techniques have been proposed for the treatment of residual defects. In particular, for intrabony defects or angular defects with a ≥ 3 mm of intrabony component, osseous grafts have been widely used. They have shown bone fill in the deepest portion of the defect (Cortellini, 1998; Selvig, 1993). This present article reports a case series demonstrating the clinical and radiographic response to 3 different surgical procedures in the

management of intrabony defects namely - open flap debridement (OFD), open flap debridement in conjunction with bone substitute coralline porous hydroxyapatite (OFD+CHA) and open flap debridement and placement of coralline porous hydroxyapatite and a resorbable collagen membrane (OFD+CHA+MEM). This follow-up also includes a surgical re-entry in the OFD+CHA+MEM site.

Case Series

2 systemically healthy patients, taking no medications that may interfere with periodontal health, diagnosed with chronic periodontitis with presence of at least 1 intrabony defect with a probing pocket depth of ≥5mm and radiographic defect depth of ≥3mm and a bleeding score of <20% at the time of surgery were selected from the out-patient department, Dept of Periodontics, Krishnadevaraya College of Dental Sciences, Bangalore. The study period including the follow-up ranged from June 2009 to August 2010. Patients with smoking habits, history of periodontal surgery in the past 6 months, grade III mobile or teeth with hopeless prognosis were excluded from the study. Pregnant and lactating women also were not chosen for the study. 2 male patients aged 35 yrs and 37 yrs respectively, with a total 3 intrabony defects satisfying the inclusion criteria were explained about the entire surgical procedure, follow-up and the expected outcomes. An informed consent was obtained.

Treatment Protocol

The treatment included the pre-surgical preparation of the patients. Both the patients underwent full mouth scaling and root planing followed by oral hygiene instructions and were scheduled for surgery 3-4 weeks later. A baseline clinical measurement consisting of probing depth, clinical attachment level, recession, plaque index, gingival index and radiograph were taken. Measurements were recorded using the UNC-15 probe throughout the study period.

Surgical Procedure: (Figures 1-8)

On demonstrating good plaque control, 3 intrabony defects from the two patients were selected. They comprised of two right maxillary first molars and 1 left maxillary first molar. 3 different treatment modalities were planned at the 3 sites comprising of open flap debridement (OFD) SITE A, open flap debridement with placement of coralline porous hydroxyapatite granules (OFD+CHA) SITE B, and open flap debridement followed by placement of coralline porous hydroxyapatite granules and adapting a resorbable collagen membrane over it (OFD+CHA+MEM) SITE C. The pre-operative probing pocket depth at the 3 sites was 9mm, 9mm and 7 mm respectively. The surgical procedure involved reflecting a full thickness flap via a sulcular (Intracrevicular) incision in order to preserve maximum amount of keratinized tissue and facilitate thorough debridement. SITE A was restricted to open flap debridement alone. The inflamed granulation tissue was thoroughly debrided and the tooth surfaces were carefully scaled and root planed.

Table 1. Evaluation of clinical parameters at stipulated time intervals

Group	Visit	SITE A	SITE B	SITE C	REMARKS
PPD	Baseline	9mm	9mm	7mm	There was a significant reduction in PPD over the time with maximum reduction occurring in first 6 months.
	3 months	7mm	7mm	5mm	
	6 months	6mm	5mm	4mm	
	9 months	5mm	4mm		
	12 months	5mm	4mm		
CAL	Baseline	8mm	8mm	6mm	Gain in clinical attachment level was more at SITE B & SITE C owing to different technique.
	3 months	6mm	7mm	4mm	
	6 months	5mm	5mm	3mm	
	9 months	5mm	4mm		
	12 months	5mm	4mm		
REC	Baseline	1mm	1mm	1mm	Post-surgical recession was not observed at SITE C only.
	3 months	2mm	1mm	1mm	
	6 months	2mm	1mm	1mm	
	9 months	2mm	2mm		
	12 months	2mm	2mm		
Radiographic defect measurement	Baseline	6.9mm	7.2mm	11mm	Bone defect fill was very significant in SITE B & C as compared to SITE A
	12 months	6.6mm	0.3mm	3.1mm	

PPD: probing pocket depth, CAL: clinical attachment level, REC: recession and radiographic defect measurement

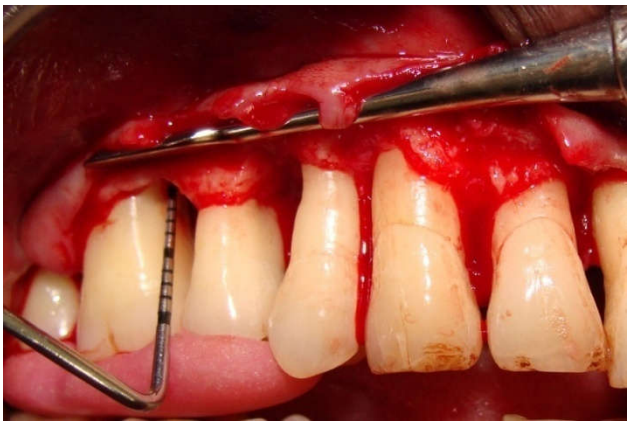
Table 2. Oral hygiene status over the study period

Group	Visit	SITE A	SITE B	SITE C	REMARKS
PI	Baseline	0.53	0.53	0.48	Plaque Index consistently reduced for first 6 months after which it was fairly constant.
	3 months	0.34	0.34	0.30	
	6 months	0.22	0.22	0.20	
	9 months	0.26	0.26		
	12 months	0.32	0.32		
GI	Baseline	0.59	0.59	0.52	Gingival Index showed similar reduction.
	3 months	0.16	0.16	0.28	
	6 months	0.09	0.09	0.16	
	9 months	0.13	0.13		
	12 months	0.13	0.13		

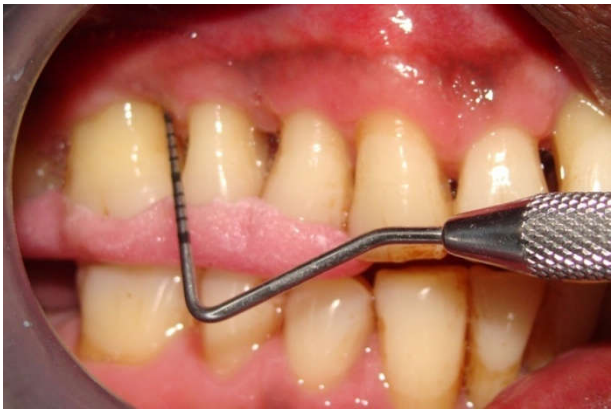
PI: plaque index, GI: gingival index

The bony defect appeared to be a 2 walled defect. No regenerative procedure was attempted, the flap margins were approximated and single interrupted sutures were given so as to obtain primary closure at the surgical site. (Figures. 1a-c)

A.Pre-operative recording (Fixed reference point-Base of pocket)



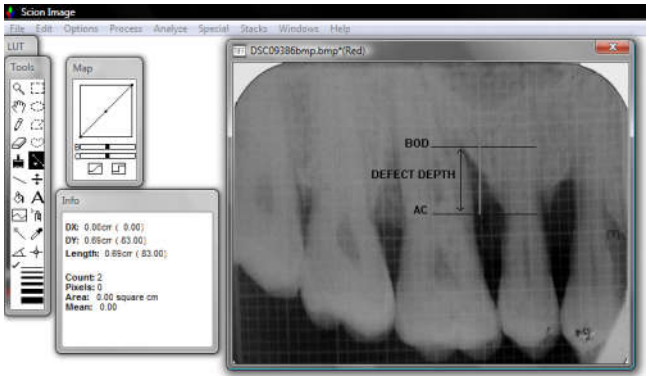
B. Fixed reference point - Base of defect



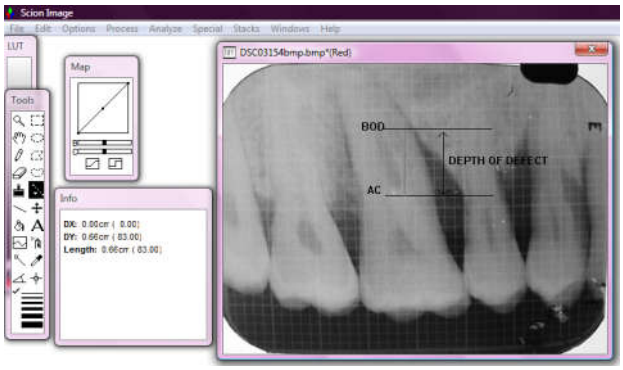
C. Site A post-operative 12 months Probing pocket depth (Fixed reference point-Base of pocket)

Figure 1. Surgical procedure on Site A

SITE B included the left maxillary molar of the same patient as SITE A. This site was operated 3 weeks after the previous procedure. Similar procedure was performed which involved sulcular incision, full thickness flap, thorough debridement, scaling and root planing of the tooth surfaces. The morphology of the defect revealed a 3 walled structure. The defect was filled with coralline porous hydroxyapatite granules (BoneMedik®) till a realistic level. Sutures were given to obtain primary closure of the surgical site and periodontal dressing was placed over it. (Figures. 3a-d)



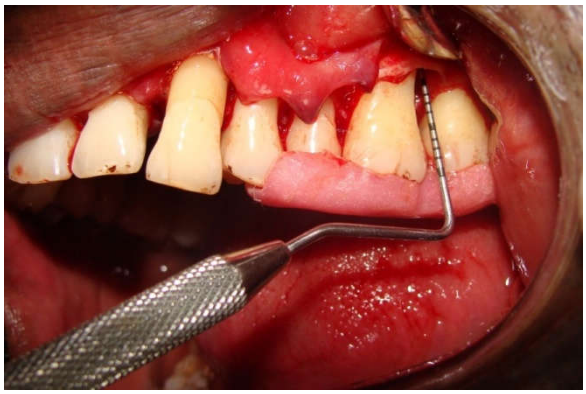
A.Image analysis (info box) showing pre-op defect depth (0.69cm)



B.Image analysis (info box) showing post-op defect depth (0.66cm)

Figure 2. Radiographs pre-op & post-op 12 months after surgical treatment

A.Pre-operative recording (Fixed reference point-Base of pocket)

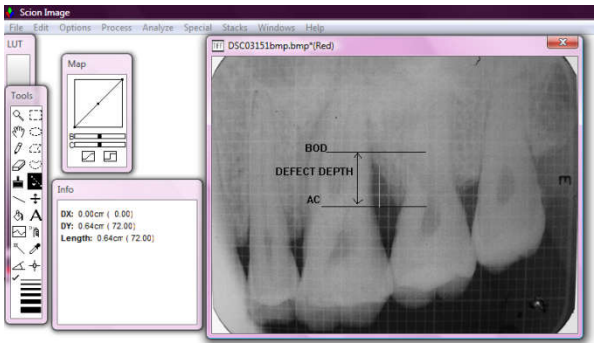


B. Fixed reference point - Base of defect

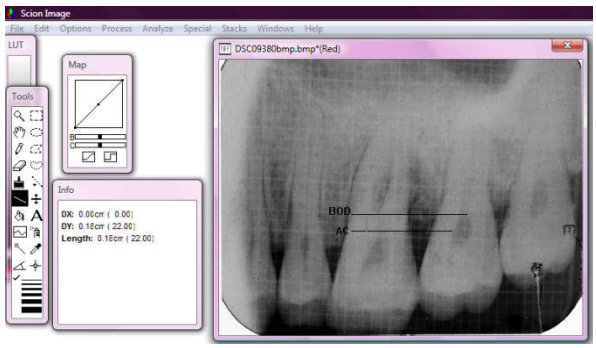
C. Bone graft placed

D. Site B post-operative 12 months Probing pocket depth (Fixed reference point-Base of pocket)

Figure 3. Surgical procedure on Site B



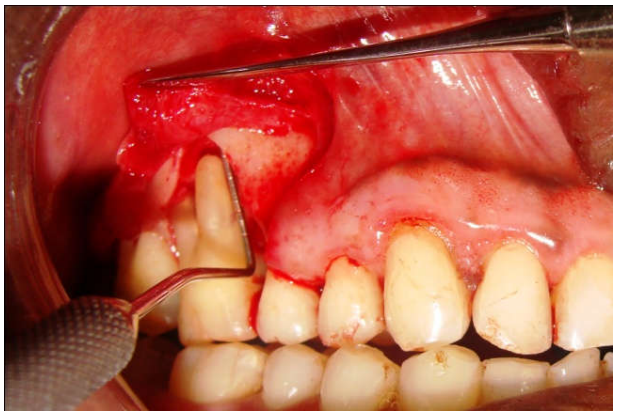
A. Image analysis (info box) showing pre-operative defect depth (0.64cm)



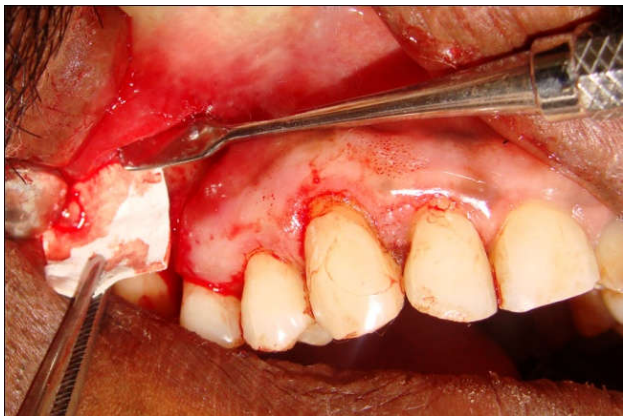
B. Image analysis (info box) showing post-operative defect depth (0.18cm)

Figure 4. Radiographs pre-op & 12 months after surgical treatment

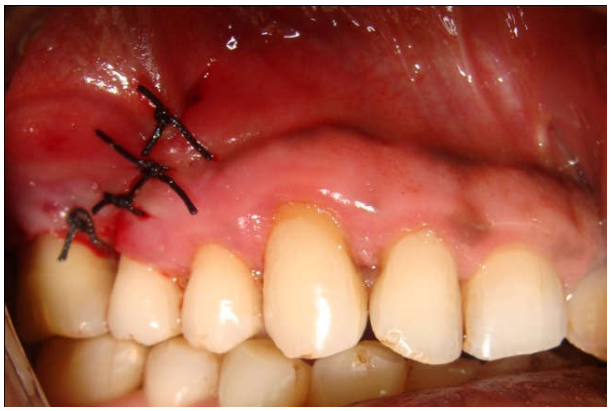
A. Pre-operative pocket probing depth



B. Flap reflection, circumferential defect present



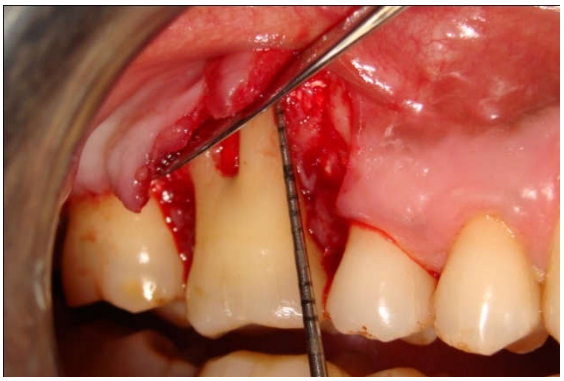
C. Bone graft & membrane placed



D. Sutures placed

Figure 6. Surgical procedure on Site C

A. Probing pocket depth at 6 months post-operative



B. Surgical re-entry (6 months)

Figure 7. Post-operative

A. Immediate post-operative radiograph

B. Post-operative (6 months)

Figure 8. Radiographs of Site C

SITE C showed a probing pocket depth ranging between 7-9 mm on interproximal and buccal surface. The attachment loss averaged 8 mm on buccal surface of the right maxillary first molar. The tooth was endodontically involved and hence root canal treatment was carried out prior to periodontal surgical therapy. Local anaesthesia was administered and full thickness flap was reflected via a sulcular incision. A vertical releasing incision mesial to the molar was also given in order to facilitate the debridement of the defect. On complete debridement, morphology revealed a 2 walled defect. Thus it was decided to treat this defect using the principle of guided tissue regeneration. After filling coralline hydroxyapatite granules in the defect, a resorbable type I collagen membrane (BioGide®) was adapted to cover and contain the graft particles. The flap was repositioned and sutured. Periodontal dressing was placed over the surgical area. A surgical re-entry at the end of 6 months was planned for this site to visualize the healing response (Figures. 6a-d). Both the patients received a complete set of post-operative instructions, both verbal and written. Post-operative antibiotic, analgesic and anti-inflammatory regime comprised of Amoxicillin 500mg TID for 7 days and Diclofenac Na 50mg BID for 3 days. Both the patients were asked to use Chlorhexidine mouthwash 0.2% twice daily for 2 weeks post-operatively. The patients were recalled 10 days after the surgery for suture removal. The further follow-up visits were scheduled at 3, 6, 9 and 12 months during which the clinical parameters were recorded and professional oral prophylaxis was carried out. Radiographs were taken at the end of 12 months.

Findings at follow-up: (Tables 1 and 2)

The follow-up period was 12 months after the surgery. Both the patients complied with the recall program. All the sites showed a reduction in probing pocket depth at the 3, 6, 9 and 12 months follow-up. There was improvement in the overall oral hygiene status of the patient. SITE A (OFD) showed a reduction in pocket depth from a pre-operative 9mm to a 12 month recording of 5mm. Thus there was a 4mm reduction in the probing pocket depth. The reduction was the result of combination of gain in clinical attachment level (3mm) and gingival recession (1mm). The pre-operative radiographic depth was 6.9mm. The radiograph revealed just 0.3 mm of bone fill as evaluated using image analysis software.

SITE B (OFD+CHA) showed a reduction in probing pocket depth from a pre-operative 9mm to a 12 month recording of 4mm. Thus there was a 5mm reduction in the probing pocket depth. The reduction was the result of combination of gain in clinical attachment level (4mm) and gingival recession (1mm). The pre-operative radiographic defect depth revealed a defect of 7.2mm. This was grafted using coralline porous hydroxyapatite granules. Radiographically the angular defect appeared to be completely filled, with the graft particles being indistinct and showing confluence with the adjacent bone. With the image analysis software the 12 months post-operative radiograph revealed a radiographic bone fill of 6.9mm. There was a negligible difference in the radiographic density of bone and the graft particle at the end of 12 months suggesting the incorporation of graft material within the bone. SITE C (OFD+CHA+MEM) showed a reduction in probing pocket

depth from a pre-operative 7mm to a 6 month post-operative 4mm. Thus there was a 3mm reduction in the probing pocket depth. No recession was reported and thus the entire reduction was attributed to the gain in clinical attachment level. Radiographically, the coralline porous hydroxyapatite initially could be seen as a radio-opaque mass with a slightly more dense appearance than surrounding alveolar bone.

A surgical re-entry procedure was planned in order to visualise the tissue response to the coralline porous hydroxyapatite granules and collagen membrane. At 6 months this difference in density was not evident and there seemed to be a blending of material into the surrounding alveolar bone in the terms of radio-opacity. A vertical releasing incision was given mesial to the first molar followed by the continuation of the same as a sulcular incision and minimal flap retraction was carried out to visualise the surgical area. On surgical re-entry, the wound site showed remarkable healing, the membrane had undergone complete resorption; the graft particles showed no mobility and were incorporated in the surrounding alveolar bone. There was new bone formation seen at the base of the defect. The flap was repositioned and sutured. Periodontal dressing was placed and patient was put on chlorhexidine mouthwash for 2 weeks. Follow-up after 2 weeks for suture removal revealed adequate healing of the surgical area.

DISCUSSION

The clinical results showed improvement in all the periodontal parameters at 12 months post surgery. Open flap debridement alone showed a reduction in pocket depth, gain in clinical attachment level and a slight increase in recession. These findings are similar with that of Kenney E B 1985 and Ramfjord 1975 (Kenney, 1985 and Sigurd, 1975). The intrabony defects treated with open flap debridement and coralline porous hydroxyapatite showed a marked improvement in all clinical parameters. This indicated that the fill of bony defects was accompanied by a concomitant improvement in the clinical attachment level and probing depth. There were no unusual adverse effects in this area and the patient reported that some particles exfoliated during the healing process (Kenney, 1985 and Sigurd, 1975). The intrabony defect treated with open flap debridement with placement of coralline porous hydroxyapatite and a collagen membrane showed remarkable improvements in the periodontal status (Schallhorn, 1988).

This site was surgically re-entered at 6 months post-surgery. The re-entry showed dramatic fill of the original defect. There was no difference between the coralline porous hydroxyapatite granules and the surrounding alveolar bone. The membrane had completely resorbed. Very few such re-entry data is available to confirm the healing of osseous grafts (Mattson *et al*., 1995 and Cortellini *et al*., 1993). Coralline porous hydroxyapatite granules and collagen membrane definitely showed an obliteration of the defect which showed; both new alveolar bone formation and assimilation of the coralline porous hydroxyapatite granules. The overlying connective tissue also appeared pink and healthy suggesting biocompatibility of the material.

Conclusion

To conclude, the 3 treatment modalities yielded results in accordance with the previous studies. The SITE A showed an adequate reduction in probing pocket depth but a minimal amount of bone fill suggesting the importance of bone grafting in intrabony or angular defects. SITE B showed an adequate reduction in probing pocket depth and also a significant amount of bone fill which remained stable over a 12 month period. This suggests the efficacy of coralline porous hydroxyapatite granules to fill the osseous defects and maintain stability of the bone fill. Also there was a resemblance in the density of the material at 12 months follow-up suggesting the compatibility of the material with surrounding healthy bone and the ability of the material to get incorporated within. The surgical re-entry procedure at the SITE C also revealed incorporation of graft particles in the surrounding healthy bone. Also the graft particles were stable and did not show any mobility. There was evidence of new bone formation at the base of the defect. These observations suggest that the coralline porous hydroxyapatite granules are compatible with the surrounding bone. Histological evaluation still remains the mainstay in assessing true periodontal regeneration but the above mentioned treatment strategies offer clinical reliability of the outcome of surgical periodontal therapy.

Conflict of interest: No potential conflict of interest relevant to this article was reported.

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