Original Article

Dental Rubber Dam as a Barrier Membrane in the Treatment of Infrabony Defects

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Abstract

Background: The ideal goal of periodontal therapy has been the regeneration of the periodontium, resulting in the complete restoration of lost periodontal tissues. This study was taken up so as to evaluate the efficacy the Dental Rubber Dam as a barrier membrane in the treatment of infrabony defects.

Methods: Fifteen patients who were diagnosed to have mild to moderate periodontitis having at least one angular defect was taken up for the study. After the routine basic periodontal therapy these sites were treated with dental rubber dam as a barrier in accordance with the principle of guided tissue regeneration. All membranes were removed after 4 weeks of membrane placement.

Results: The results showed a significant improvement in all clinical parameters including reduction in periodontal probing depth and gain in clinical attachment level after six-nine months post-operatively. Radiographic measurements also showed a mean reduction in osseous defect depth of 0.94 mm. The sites however, showed an increase in gingival recession amounting to a mean of 1.46 mm.

Conclusion: It can be concluded that dental Rubber dam is a barrier membrane with great potential in treatment of periodontal osseous defects provided the limitations brought to light in this study are addressed in the future. At present it can only be recommended for the treatment of osseous defects in the posterior teeth aesthetics is not a prime concern.

Keywords: Barrier membranes, Rubber dam, Periodontal regeneration, Infrabony defect

INTRODUCTION

Barrier membrane helps in periodontal regeneration by preventing the migration of epithelial cells and cells from the gingival connective tissue onto the root surface. There are different types of membranes that can be used to regenerate periodontal tissues. Most of the commercially available regenerative materials are very expensive and not within the reach of the common man especially in developing countries. Investigations have still to be undertaken to find more materials that are cost effective and possess all the required characteristics, as stated above, of an ideal barrier membrane.

The ideal goal of periodontal therapy has been the regeneration of the periodontium, resulting in the complete restoration of lost periodontal tissues.[1] Periodontal regeneration is the regeneration of the tooth's supporting tissues including cementum periodontal ligament and bone.[2]

The methods currently employed to obtain periodontal regeneration are the use of osseous grafts (including autografts, allografts and alloplasts),[3-5] chemical mediators (citric acid, tetracycline, polypeptide growth and differential factors and enamel matrix proteins), interdental denudation,[6] coronally positioned flaps and the use of tissue guiding membranes. Combination of one or more of the above had been tried and tested with favorable results.

While reports of successful periodontal regeneration can be found throughout the periodontal literature there can be little doubt that traditional surgical or non-surgical approaches to periodontitis do not generally lead to regeneration.[7-10]

Guided tissue regeneration (GTR) is based on principles of wound healing as espoused by Melcher.[11] He hypothesized that the cells that repopulate the periodontal wound determine the nature of attachment at the tooth-soft tissue

interface. Melcher originally felt that the progenitor cells to produce the regenerated cementum, periodontal ligament and bone are derived from periodontal ligament cells.

Besides the use of the common commercially available membranes, unusual regenerative materials have been used as a barrier in guided tissue regeneration technique in both animals and humans. Studies using silicon rubber, periosteum, connective tissue membranes as well as dura-mater allografts[12,13] have also been reported. More recently studies have presented the successful use of dental rubber dam in the treatment of periodontal infrabonydefects.[14-16]

The ideal requirements of any material to be employed as a barrier membrane include biocompatibility, the ability to retard epithelial migration, manageability, adequate rigidity for space maintenance and the ability to allow tissue integration.[17] In addition to the necessary membrane characteristics listed above, an important pre-requisite for successful periodontal GTR therapy is proper membrane placement.

The use of dental rubber dam (DRD) as a barrier membrane has been suggested due to its good manageability, close adaptation to the root shape, particularly in the presence of root surface interproximal concavities, the possibility of simultaneously treating multiple adjacent periodontal defects, the ability to seal off the coagulum from bacterial contamination and negligible economic cost.

Most of the commercially available regenerative materials are very expensive and not within the reach of the common man especially in developing countries. Investigations have still to be undertaken to find more materials that are cost effective and possess all the required characteristics, as stated above, of an ideal barrier membrane.

In a five case-report presented by Cortillini and Pini Prato[14] to assess the efficacy of dental rubber dam (DRD) as a prospective barrier membrane, all patients presenting with at least one inter-proximal infrabony defect of 3 mm or more with no furcation involvement were taken. A 1-year CAL gain ranging from 3 to 5 mm was observed along with a marked reduction in the probing pocket depth (PPD). The residual PPD at 1-year ranged from 2 to 3 mm. The bone gain ranged from 3 to 5 mm. A slight 1-mm resorption of the inter-proximal crest of the bone was observed in two sites.

Later next year, Salama et al.[16] treated ten patients who presented themselves with at least four sites in a quadrant exhibiting probing depths of 7 mm or greater and the presence of existing multiple osseous defects for which regenerative treatment utilizing the principles of GTR would require the placement of more than commercially available membrane. They found that all membranes became exposed inter-proximally by the second weekly visit. Attachment gain among sites ranged between 1 and 8 mm. The range among patients was 2 to 5 mm of new clinical attachment. The mean gain of probing attachment for all sites in all patients was 3.84 mm. The range of osseous regeneration (measured by open probing) was 2.4 to 7.5 mm. The mean osseous fill for all sites was 4.25 mm. Three of the patients exhibited supra-crestal osseous regeneration. The remaining patients had defect fill that ranged from 80% to 95%.

More recently Michele Paolantonio et al[15] (1998) carried out a clinical study to confirm the validity of dental rubber dam as a suitable material in regenerative procedures. They also compared the effectiveness of dental rubber dam-made membranes and ePTFE barrier membranes in the treatment of periodontal intra-bony defects. They found that in both test and control site, a statistically significant improvement of clinical and intra-surgical parameters occurred at the end of the study; however, a significantly greater improvement was observed in control sites for probing attachment level (+4.0 mm versus +3.0 mm; $p<0.01$) and vertical bone gain (3.9 mm versus 2.9 mm; $p<0.05$) although at the time of membrane removal, newly formed tissue from the base of the defect was similar between the experimental sites (test: 5.8 mm; control: 5.6 mm; $p>0.05$). Conversely, test sites exhibited a statistically significant greater increase in gingival recession (+1.9 mm versus +1.2 mm; $p<0.05$) and alveolar crest resorption (−1.1 mm versus −0.3 mm; $p<0.01$) in comparison to controls.

Keeping the above factors in view an attempt has been made to evaluate the efficacy of dental rubber dam as a barrier membrane in the treatment of infrabony defects through clinical and radiological assessment and also to assess the advantages and disadvantages of the material as a prospective occlusive membrane. Clinical parameters include the measurements such as reduction in probing pocket depth, gain in clinical attachment level, change in level of gingival margin and mobility for the group of teeth selected for the study and indices to measure the gingival status and plaque percentage of the subjects. Radiographic assessment includes reduction from baseline osseous defect depth parameters and amount of bone fill as assessed six-months post-operatively.

MATERIALS AND METHODS

Patient Selection and Pre-Surgical Procedure

Fifteen patients (eight males and seven females) aged 20-50 years diagnosed as having moderate to severe

periodontitis presented themselves to the Department of periodontology, M.R.Ambedkar Dental College and Hospital. All subjects had a minimum of one infrabony defect as diagnosed clinically and confirmed radiographically. All patients were briefed of the surgical procedure, including the material to be used and a requirement of two surgical sittings, and an informed consent was obtained.

A special Performa was used consisting of a detailed case history, clinical examination and recordings of clinical parameters at baseline, three-month and six-month interval. The clinical parameters included plaque index (Silness and Loe),[2] gingival index (Loe and Silness),[18] periodontal probing depth (PPD), clinical attachment level, gingival recession and tooth mobility.

Radiographic measurements consisted of Intra-oral peri-apical (IOPA) radiographs utilizing the long cone extension methodology.[19] Radiographic assessment was made by scanning the radiographs utilizing a transmissive scanner at 1200 dpi resolution. Measurement was being made using Adobe PhotoShop 5.5™ software.

Pre-surgical periodontal treatment consisting of infection control (mechanical and chemical), supra-gingival and sub-gingival scaling, elimination of plaque retentive factors, occlusal control, elimination of caries and endodontic treatment was performed.

Inclusion Criteria

1. Subjects with moderate to advanced periodontitis as assessed by clinical and radiographic findings.
2. Subjects presenting with two-walled or three-walled infrabony defect or combination defects were included.

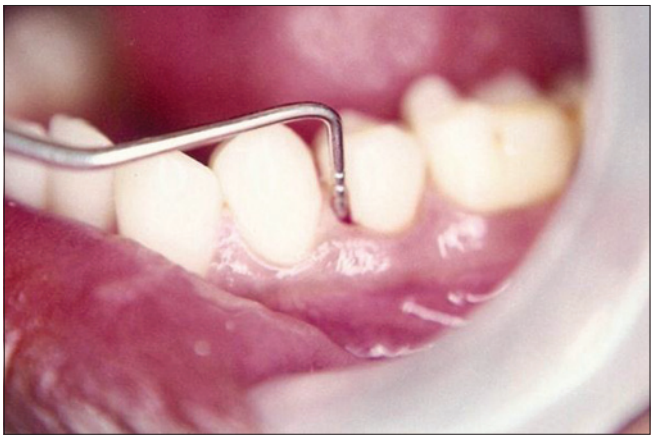
Exclusion Criteria

1. Subjects with known history of systemic disease/s, allergies or drug usage that would alter the healing response of the oral tissues were excluded.
2. Subjects who had undergone periodontal treatment within six months prior to the present study were excluded.
3. Sites presenting with clinical/radiographic evidence of pulpal pathosis were excluded. One defect adjacent to an endodontically treated tooth was however included.
4. Furcation involved teeth were excluded.
5. One-wall defects and narrow three-walled defects were excluded from the study.

The study sites comprised of ten posterior and five anterior teeth and all cases showed a plaque percentage lesser than 10% at the time of surgery. Amongst the patients recalled, three patients did not return for revaluation.

SURGICAL PROCEDURE

Following anesthesia, Facial and palatal/lingual full thickness envelope flaps were raised utilizing intra-sulcular incisions to maintain the maximum amount of gingival tissue for membrane coverage. The flaps were extended one tooth mesial and one tooth distal to the defect site. Alveolar bone was exposed for at least 3 mm apical to the base of the defect and periosteal fenestration was made to assure complete membrane coverage at the time of suturing. The defects were thoroughly debrided and the roots were carefully planed with ultrasonic and hand instruments.



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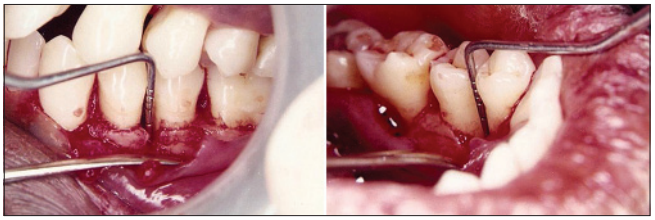
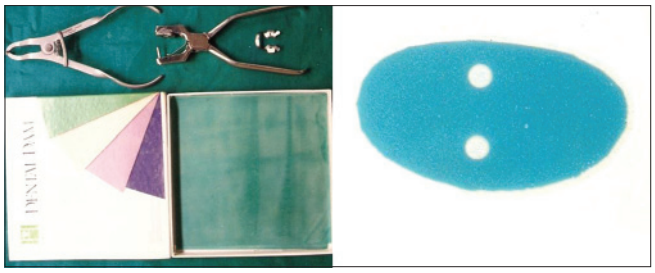


Angular bony defect seen after flap reflection and debridement on buccal and lingual aspect

The rubber dam material (cispolisoprene)1* was cut into small pieces depending on the defect area. The dental rubber dam (DRD) was previously disinfected by carefully washing with distilled water and autoclaved at 120°C. Following which it was submerged in 0.2% chlorhexidine for 12 hours, and rinsed with saline solution before use.

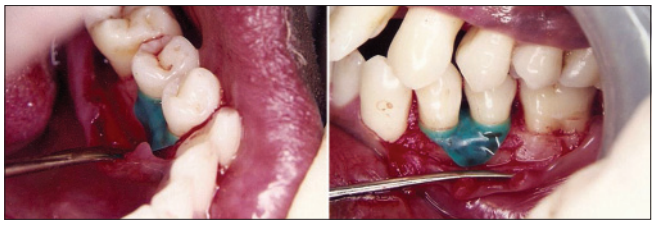
The dental rubber dam was positioned as the same way as when teeth are isolated for restorative procedures. One hole was punched in the dam for each tooth adjacent to the defect utilizing a rubber dam punch. The dam was then stretched over the teeth, to place it as a poncho over the denuded bone.

*Hygenic™ latex dental rubber dam-medium thickness (0.008 inch/ 0.2 mm)

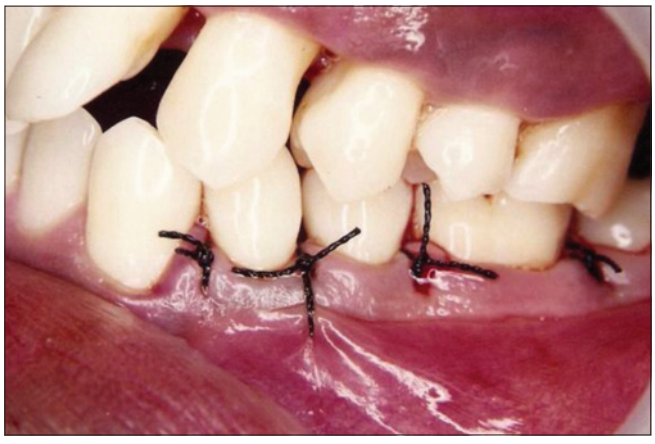


Dental Rubber Dam

It was then adapted and reshaped once in place to eliminate the excess peripheral portions including all sharp edges. The flaps were sutured to cover the rubber dam at the maximal possible extent, avoiding any compression of the area where the infrabony defect was located. Vertical mattress sutures were placed using a non-absorbable black braided silk suture at the defect site and simple interrupted sutures were placed wherever necessary.



Placement of Rubber Dam on the buccal and lingual aspect extending 2-3 mm apical to alveolar crest

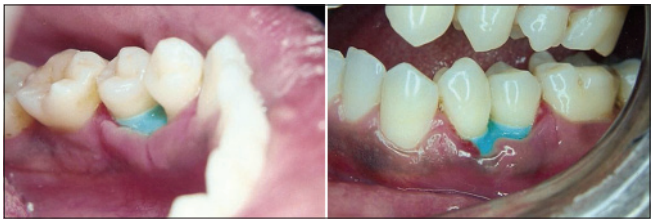


Sutures placed

A periodontal dressing (Coe-Pak™) was placed and the patients were dismissed with a prescription of 1 g of tetracycline hydrochloride per day during the first post-operative week and instructed to rinse twice daily with 0.2% chlorhexidine (Hexidine™). Professional tooth cleaning was performed weekly once while the membrane was in place and monthly once following membrane removal.

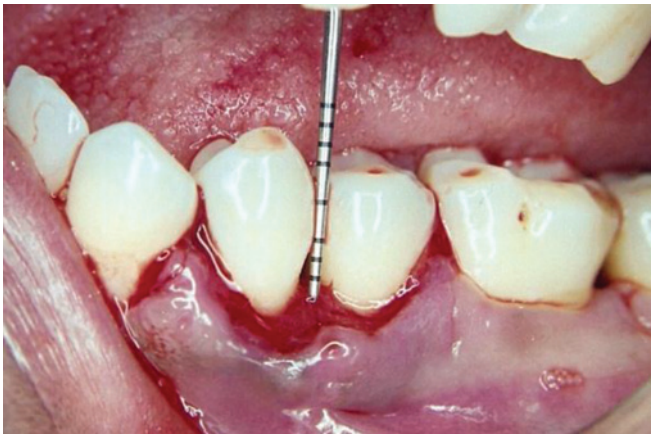
Four weeks after placement, the DRD was removed after elevation of a partial thickness flap. Following de-epithelialization of the inner walls of the flaps, it was positioned and sutured to obtain the best possible coverage of the newly formed tissue. Periodontal dressing was applied and the patients were re-instructed to rinse twice daily with 0.2% chlorhexidine.

The dressing and sutures were removed after 1 week and patients were instructed to resume tooth brushing in the area and discontinue the chlorhexidine mouthwash.

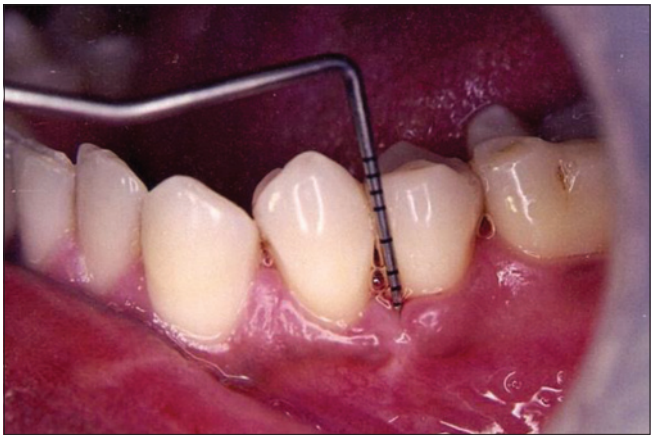


Experimental site at 4 weeks postoperatively

(Prior to membrane removal)



Surgical site after DRD removal



Six month post-operative

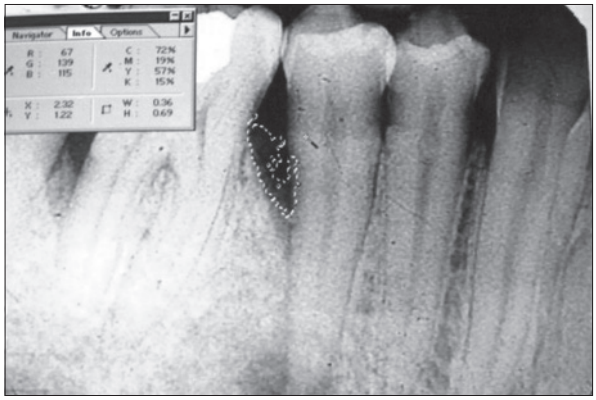
CLINICAL AND RADIOGRAPHICAL MEASUREMENTS

Clinical Measurements

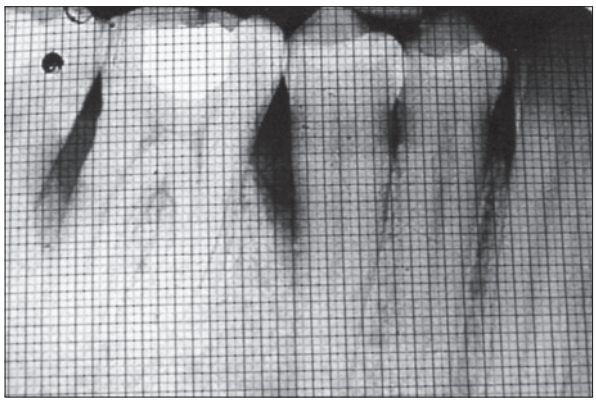
- Probing depth (PD)
- Attachment level (AL)
- Recession

Radiographic Measurements

A unique method was employed to radiographically determine the amount of hard tissue changes. This was assessed by initially scanning the pre- and post-operative Radiographs at 1200 dpi resolution using a Hewlett Packard transmissive scanner. These images were then imported into a graphic programming software, Adobe PhotoShop 7.0™. The images were then sharpened and the contrast adjusted so-as to clearly de-mark the anatomical landmarks consisting of cementoenamel junctions, alveolar crest and base of the defect. These landmarks were then marked using a colored "pen" tool.

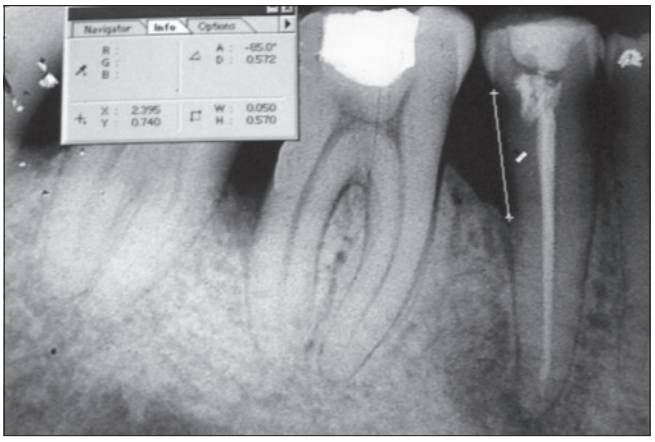


Use of 'magic wand" tool to detect areas of similar contrast



Radiograph with grid lines for alternative

Following this, the "scale" tool was utilized to measure the distance from the respective points. The scale determined the distance to an accuracy of 0.01 cm. To further aid in measurements an alternative of grid lines was also utilized.



"Scale" tool used to measure the distance between landmarks in mm

The measurements made include:

- CEJ to Base of the defect (BOD)
- CEJ to Alveolar crest (AC)
- Alveolar crest to base of the defect

It should be noted here that the CEJ of the tooth that is closest was considered, i.e. the CEJ considered to measure the distance to the BOD or AC is never the same.

The percentage of bone fill was calculated using the formula:

$$\frac{\text{CEJ}-\text{BOD}\ (\text{pre}-\text{op})\ -\ \text{CEJ}-\text{BOD}\ (\text{post}-\text{op})}{\text{AC}-\text{BOD}\ (\text{pre}-\text{op})}\times 100$$

All the data obtained in this study were evaluated statistically by using student's paired t-test.

RESULTS

Fourteen patients with presence of at least one vertical osseous defect as verified by clinical and radiographic evaluation were selected for this study. Four to six weeks after basic therapy, periodontal flap operations were carried out with placement of dental rubber dam in 15 experimental sites. All membranes were removed in the fourth week. The patients were recalled at regular intervals and were followed in the range of six-nine months. All the patients participated for the entire study period. All measurements were analyzed statistically using student's paired "t" test. Baseline and six-month complete plaque and gingival scores were less than 10% in all of the patients. The level of gingival inflammation around the membrane ranged from mild to moderate.

General Findings

There were no post-operative complications of any kind in any of the patients. The rubber dam did not cause any objectively recorded adverse effects and none of

the patients reported any sort of discomfort during the period in which it was in place. No allergic reaction to the material, neither any swelling nor suppuration was noted. It was noted that all membranes became exposed inter-proximally by the second weekly visit. In three patients there was small perforation in the facial gingival resulting in membrane exposure, however, no signs of inflammation were seen in these areas.

Clinical Assessment

Probing Pocket Depth and Attachment Gain

A significant reduction was observed in the probing pocket depth. The mean probing depth before surgery was 6.8±1.26 mm and six-month post-operative measurement was 2.4±0.90 mm. This was found to be statistically highly significant ($p<0.001$).

A highly significant gain in attachment level was also recorded ($p<0.001$). The mean attachment loss prior to surgery was 6.8±1.26 mm and six-month post-operative measurements showed an attachment loss of 3.93±1.03 mm.

Gingival Recession

Twelve of the fifteen subjects showed a significant shrinkage in the gingival margin, which was the most important and undesirable finding. While none of the sites showed recession pre-operatively, a mean average recession encountered at the end of the study period was 1.53±0.12 mm.

Radiographic Assessment

Bone-Fill

The sites that were treated with the barrier membrane showed a significant amount of bone fill. The mean distance from cementoenamel junction to base of defect prior to study was 10.49±2.72 mm and at six months there was a reduction to 9.33±2.72 mm. This was statistically significant. Some amount of resorption of alveolar crest was recorded at the end of study. A mean of 4.54±1.36 mm resolved to a height of 4.75±1.54 mm. The overall percentage of bone fill was 16 %, which was statistically significant.

DISCUSSION

Ever since Melcher[11] formulated the hypothesis suggesting that selected cell population residing in the periodontium can produce new cementum, alveolar bone and periodontal ligament provided that these population are given an opportunity to occupy a periodontal wound a number of devices have been used to achieve this concept of GTR. Starting from a Millipore filter different types of barrier membranes both non-absorbable and absorbable have been used in periodontal therapy with different degree of success.

For a device to be effective it has to meet certain criteria based on organ and tissue properties and specific goals. These include bio-compatibility, cell exclusion, space maintenance, tissue interaction, ease of use and biological availability. Further, such a device must be cost effective.

Considering the above requisites many unusual materials have been tried as barrier membranes. One of which is dental rubber dam (DRD). The spectacular success reported in a couple of studies prompted its use in this study.

The results from this study shows that DRD used as a barrier membrane in guided tissue regeneration produces a significant reduction in probing depth, gain in clinical attachment level (CAL), and bone fill. In the present study a mean attachment gain of +2.9 mm and an average bone gain of +0.94 mm was recorded.

However, spectacular changes in the radiographs were probably not seen because of duration of short post-operative observation. More perceptible radiographic changes would perhaps become evident if these cases are observed for a longer duration of time.

Notwithstanding the significant gains in reduction of periodontal probing depth (PPD), gain in CAL and other clinical features, the use of DRD in this study resulted in changes, which could seriously limit the use of this material.

12 out of 15 defects treated developed post-operative gingival recession. Although many previous studies using ePTFE have reported gingival recession (GR) following the use of barrier membrane, this is nevertheless unwelcome sequelae. Some of the clinicians have tried coronal repositioning of the flap but some degree of GR always occurred.

Secondly, the exposure of the DRD starting from the second post-operative week despite maximum effort to approximate the flaps with sound suturing technique is of concern to the clinician. In every study using DRD as a barrier membrane, interproximal exposure of the dam has been reported including the present study. Although, this did not result in any infection, what effect such as exposure of the material had on the final outcome of the treatment is difficult to assess.[10,20,21]

Perforation of the tissue with subsequent exposure of the dam seen in two cases of the study is an avoidable complication. This might have been probably because of sharp edges and folding of the DRD and might have

been prevented if the edges of the dam was sutured to the periosteum.

Because of GR seen at the time of removal of DRD there was always a chance of incomplete coverage of the newly formed granulation tissue, which is very vital for ensuring periodontal regeneration. In one study efforts were made to re-suture the flaps in order to protect the newly formed granulation tissue. All these procedures might place additional stress on the patient.

The lack of connective tissue integration into the membrane because of the smooth and non-porous nature of the DRD resulted in inadequate stabilization of the membrane and consequently made maintenance more demanding as it resulted in not only earlier exposure of the membrane but also enhanced epithelium migration down the inner aspect of the mucogingival flap compared with the other materials.

The limitation cited above not withstanding the DRD as a barrier membrane demonstrated important desirable characteristics. Its tight fitting and adherence to the root circumference along with its ability to be placed at a more coronal level compared to other ePTFE membrane could result in greater amount of newly formed tissue. Further, its ability to adapt to complex root morphology such as concavities is a distinct advantage.

Bacterial aggregation on the membranes has been mentioned as a major disadvantage in many studies prompting some clinicians resorting to use the use of local drug delivery systems to combat the same. However, this problem may not be seen in DRD as little bacterial aggregation can occur on the DRD due to its non-porous surface. Also, the dam protected the regenerative space from infiltration by epithelial cells as well as influences of saliva and bacterial and their byproducts.

The ability of the DRD to treat multiple adjacent infrabony defects simultaneously is a distinct advantage over other materials.

That there was no tissue reaction whatsoever in any of the cases shows the excellent bio-compatibility of the material which is a major advantage.

Most of the commercially available barrier membranes for guided tissue regeneration therapy in India are very expensive and therefore beyond the reach of most of the patients. The low price of DRD is certainly a major positive and desirable factor in the periodontal treatment of patients belonging to the economically poorer section of the society.

Many of the previous studies have used re-entry at the end of one year to assess the clinical outcome. However, since the patients had already undergone two surgical procedures during the duration of this study, a third surgery in the form of re-entry was not considered, instead a new innovative radiographic method of estimation to evaluate the changes in the bone was employed. However, variations in the degree of exposure, developing and fixing of the radiographs might have contributed to variations in the interpretation of the results.

Microbiological assessments also need to be looked into in future studies. Further follow up over a long period of time will throw more light on the efficacy and maintainability of these procedures.

One of the problems encountered with DRD is its lack of rigidity. If the same material can be reinforced to make it a little more rigid, possible collapse of the membrane into the defects could be prevented. Further, if the cervical portion is made tissue adherent this might result in better tissue adaptation and also might prevent recession. Further studies can look into these factors.

CONCLUSION

It can be concluded that dental Rubber dam is a barrier membrane with great potential in treatment of periodontal osseous defects provided the limitations brought to light in this study are addressed in the future. At present it can only be recommended for the treatment of osseous defects in the posterior teeth aesthetics is not a prime concern.

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