Original Research Paper

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Revisiting "Plaque Free Zone"- Island of Peace in a Zone of Conflict: A stereomicroscopic study

Abstract:

Aim: This study was undertaken to find if Plaque Free Zone (PFZ) indeed was a ubiquitous entity observed both on healthy and diseased teeth and further to compare the width of PFZ in healthy and diseased teeth.

Material & Methods: Out of total 31 teeth, 18 teeth extracted from patients with chronic periodontitis and 13 teeth extracted from healthy individuals were examined. The teeth were stained and measurements of width of PFZ were made. Photomicrographs were taken at 20X magnification using a stereomicroscope & measurements were made using Image J software. The data obtained was subjected to statistical analysis.

Results: A significantly wider PFZ was found on the surfaces of teeth of healthy group as compared to diseased group.

Conclusion: Wider PFZ zone in healthy teeth may have a protective role preventing direct contact of bacteria with underlying periodontal ligament. Invasion of this zone during mechanical instrumentation needs to be avoided.

Clinical Significance: The existence of plaque free zone has clinical implications. Instrumentation beyond the base of the pocket during SRP may upset the delicate balance existing at tooth sulcus/pocket interface

Key-words: Plaque Free Zone, Non-Stained zone, Stereomicroscopic Study, Chronic Periodontitis

Introduction:

Bass was the first one to elucidate a non-stained region or area usually found on the smooth surfaces of diseased as well as non-diseased, stained, extracted teeth.[1]This non-stained region is demarcated on the coronal side plaque on marginal gingiva and apical side by junctional epithelium on the enamel of non-diseased teeth. This region or area is congruous with healthy crevice corono-apically before removal of tooth and the micro-organisms in this region are comparatively less.[2] It was demonstrated on extracted, stained permanent as well as primary teeth.

Brady in 1973 investigated this zone using scanning and transmission electron microscopy on healthy as well as periodontitis affected teeth. He also stated that this region was almost devoid of the microbes and resent in the middle of apical plaque border and the attachment epithelium, and termed it as the "plaque-free zone" (PFZ).[3] Numerous studies have been done with respect to the main or principal structural units of this region on enamel but very few have focused on its features of diseased teeth.[4,5]Teeth affected by periodontitis or the diseased teeth, PFZ apical boundary has been depicted as the coronal border of residual principal fibers of the periodontium.[6,7] Despite of the fact this region is presently mentioned to as plaque free zone and this word is widely used, its apical limit on the root surface of diseased teeth and the title of plaque free still needs to be analyzed through research studies.

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Absolute removal of dental or bacterial plaque must be the main aim in the treatment of periodontitis. Clinically it is difficult to remove plaque completely, especially in the areas of deep periodontal pockets.[7]Various studies have documented the existence of this non-stained region or plaque free area on the surface of extracted teeth which lies in between the coronal boundary of periodontal ligament and innermost line of plaque.[1,3,8]

The instrument should get as far as or extend beyond the apical part of the deposits in order to gain absolute elimination of plaque, debris or calculus for treating periodontally affected teeth. Therefore, one should be well versed with the framework and anatomy of the plaque-free zone for successful treatment of periodontally compromised teeth.[7]

Hence, goal of the study was to determine if this plaque free zone or region indeed was a ubiquitous entity observed both on healthy and diseased teeth and further to compute the width i.e. wideness of plaque free zone on the teeth which were periodontally compromised i.e. chronic periodontitis affected teeth. Objectives of the study were a) comparing width of Plaque free zone on all the four tooth surfaces i.e. mesial, distal, buccal and lingual surfaces of healthy & periodontally diseased teeth, b) comparing width of Plaque Free Zone of all four surfaces between chronic periodontitis affected teeth (diseased group) and healthy group and c) comparing the width of Plaque Free Zone of all surfaces in diseased Single rooted and multi-rooted teeth.

Materials and Methods:

The research included 13 extracted human teeth which were in good health i.e. non- diseased (mainly orthodontic removal) and 18 extracted teeth which were affected by chronic periodontitis, gathered right away after removal from patients sent to the Oral & Maxillofacial Surgery Department. All patients in the study were well informed about the research that would be conducted on their extracted teeth i.e. both Written and Informed consent was procured from all patients. Teeth with instrumented surface and open carious lesions were excluded from the study. In all, 124 surfaces of 31 teeth extracted were further examined.

The extracted teeth were then segregated into two categories: Diseased/ Group 1 and Healthy/ Group 2. The Diseased Group was further subdivided into: Multi Rooted Teeth group and Single Rooted teeth Group and were processed accordingly.

After extraction the tooth was immediately rinsed under running water to wipe off or shed the blood and debris. Further teeth were kept and preserved in 4% formalin solution. Then, extracted teeth were subjected to staining by 1% aqueous crystal violet stain solution for 20 seconds, flushed with water and thereafter immersed and stirred in 70% ethanol for 20 seconds to differentiate the stain.[9,10]The stained tooth surface was examined under stereomicroscope and photomicrographs, were obtained at 20x magnification of all the four surfaces (mesial, distal, buccal and lingual) of teeth of the healthy (Figure 1)as well as the diseased group (Figure 2). The width of a non-staining zone was then calculated on the photomicrographs using Image J software.

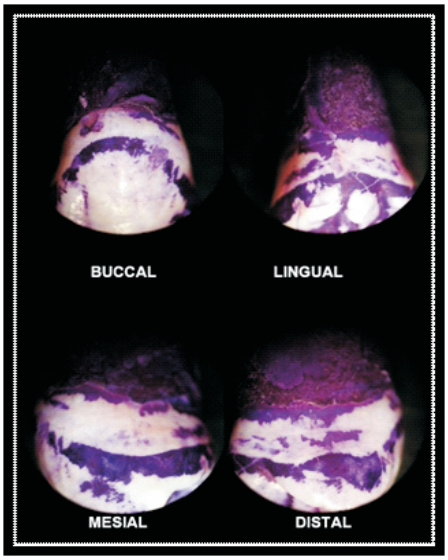

Figure 1. Healthy Mandibular 2nd Premolar Surfaces

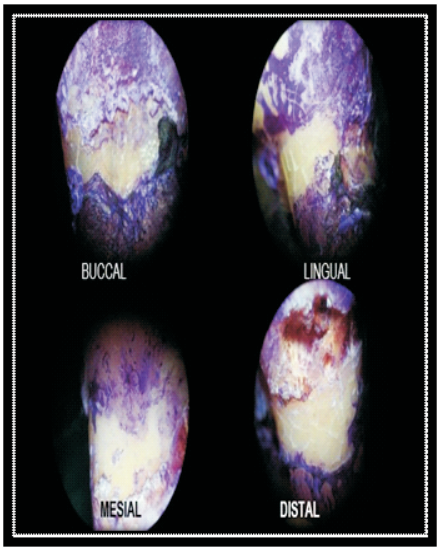

Figure 2. Chronic periodontitis affected Mandibular 2nd Molar

Results:

The statistical analysis was performed and result measurements were presented in number and mean±SD. Two tailed, independent Student t test (two tailed, independent) was used to find the significance of study parameters between two groups on a continuous scale. Value of p less than 0.5 was considered statistically significant.

Each photomicrograph taken showed an unstained zone i.e. the plaque free zone, which was limited by dark stained zone as shown in Figure 1 and Figure 2. Individual measurements ranged from 0.63 mm to 2.12 mm in teeth affected by chronic periodontitis and ranged from 1.01 mm to 2.15 mm in healthy teeth. The mean width of plaque free zone was 1.21±0.39 mm in the diseased group and 1.53±0.21mm in healthy group & there was a statistically significant difference among both groups.

The plaque free zone was found to be wider on the buccal, lingual & distal surfaces of healthy group than diseased group & the differences were statistically significant. The PFZ was wider on the proximal surfaces than on the buccal and lingual surfaces (Table 1). Mean width of plaque free zone on all surfaces of the multi-rooted teeth was higher compared to the single rooted teeth. However the differences in both groups did not show statistical significance (Table 2).

Table 1: Comparison of width of plaque free zones (PFZ) in the diseased and healthy groups

	GROUP 1 (Diseased Group)	GROUP 2 (Healthy Group)	p- value
Buccal (mm)	1.21 ± 0.39	1.53 ± 0.21	**0.014***
Lingual (mm)	1.08 ± 0.33	1.37 ± 0.34	**0.024***
Difference between Buccal & Lingual	0.13 mm	0.16 mm	-
Mesial (mm)	1.38 + 0.38	1.55 + 0.17	**0.152**
Distal (mm)	1.21 + 0.32	1.66 + 0.36	**0.001****
Difference between Mesial & Distal	0.17 mm	-0.11 mm	-

+Suggestive significance (0.05<p<0.10), * Moderately significant (0.01<p < 0.05)** Strongly significant (p < 0.01)

Table 2. Comparison of width of PFZ in Multi-rooted and Single rooted groups

	Multi rooted teeth group	Single rooted teeth group	p - value
Buccal (mm)	1.36 ± 0.37	1.01 ± 0.36	0.062
Lingual (mm)	1.16 ± 0.33	0.98 ± 0.31	0.249
Difference of Buccal & Lingual	0.20mm	0.03mm	-
Mesial (mm)	1.49 + 0.38	1.25+ 0.36	0.184
Distal (mm)	1.25 + 0.36	1.16 + 0.26	0.529
Difference of Mesial & Distal	0.24mm	0.09mm	-

+Suggestive significance (0.05<p<0.10), * Moderately significant (0.01<p < 0.05)** Strongly significant (p < 0.01)

Discussion:

This present stereomicroscopic study showed the presence of a unstained areain middle of the apical most border of plaque and the periodontium or periodontal fibres attached in healthy as well as chronic periodontitis affected teeth which confirm the observations of previous studies.[11,12] The term "plaque free zone" coined by Bradywas used in this study to demarcate the area located within the apical most border of plaque and the coronal boundary of attachment fibres.[3]

The mean width of plaque free zone was 1.21+0.39 mm in the diseased group (Figure 2) and 1.53+ 0.21mm in the healthy group (Figure 1)& the width of the zone was related to presence or absence of disease. This zone in periodontally diseased teeth probably corresponds to area previously occupied by the epithelial cell–associated biofilm and/or a weakly attached or unattached zone of microorganisms, which may be lost during extraction.[13]

Previous studies have shown a wide disparity in the width of non-staining zone free from plaque, which ranges from 75-85 microns on enamel surface to 145-440 microns on the root surface. Earlier studies also revealed that in permanent teeth, PFZ and attachment loss tended to show an inverse relationship.[7,8,10]Structure of the PFZ was studied by Saglie et al who described epithelial remnants within the zone[7]& reported that zonal width this region showed reduction with the increase of depth of pocket and attachment loss. Results of the study are in accordance with the previously published literature.

The present study revealed that measure of plaque free region in single rooted teeth was narrower as compared to the multi-rooted teeth in healthy as well as chronic periodontitis affected teeth which was in accordance with the previous studies.[7]An area of plaque free zone in the deepest part of furcation in the multi-rooted teeth, could be of great importance while treating the furcation.

The presence of PFZ in healthy & diseased tooth as well as its role in pathogenesis is still not clear and needs further exploration. The regular existence of the plaque free region between the apical most border of plaque and junctional epithelium may be attributable to local host responses operating at the region of gingival sulcus/pocket. Therefore, the plaque-free zone may safeguard the tooth throughout the disease activity by representing a defense area between the plaque bulk and the localized immune responses.[14] Researches have clearly shown that chemical plaque control

even if it does not outreach or extend till the entire pocket will be effective if it gets as far as the apical most plaque border. And few studies have shown these results by using 0.2% chlorhexidine gluconate daily for subgingival plaque control.[15]

Although this study verified & confirmed the presence of the zone free from plaque or non-stained zone in teeth with periodontitis this study has some limitations. We used a stereomicroscope as against a SEM which is known to provide high quality detailed images with good resolution. Also, only width of the zone was measured but not correlated to the extent of attachment loss & no attempt was made to examine the structural characteristics of this zone. Future studies are needed to address some of the limitations of our study.

Conclusion:

Within the limits of the study, results have verified the existence of a zone free from plaque, on teeth with chronic periodontitis, & confirmed that the width of this zone was narrower on periodontitis affected teeth compared to healthy teeth. Future research on the non- staining zone with a large sample size and histological evidence is necessary to further delineate the potential clinical benefits and alleviate its clinical implications in the field of non-surgical periodontal therapy.

Clinical Significance:

This critical zone could play a defensive role during clinical course of periodontal disease by preventing bulk access of plaque to the deeper structures of the periodontium. The prevalence of the zone free from plaque has clinical implications which may change the way of treating aperiodontally compromised tooth. Instrumentation beyond the base of the pocket during SRP may upset the delicate balance existing at tooth sulcus/pocket interface.

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