

Research Article

Quantitative Light-Induced Fluorescence (QLF) in Assessing the Efficacy of Dental Floss as An Adjunct to Toothbrushing

Sheela Kumar Gujjari^{1*}, Raghavendra Shanbhog², Kritika Banerjee³, Swathi Vathsa³

¹Professor and Head, Department of Periodontology, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, Mysuru, India

²Reader, Department of Pedodontics and Preventive Dentistry, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, Mysuru, India

³PG Student, Department of Periodontology, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, Mysuru, India

Correspondence author: Sheela Kumar Gujjari, MDS, Professor and Head, Department of Periodontology, JSS Dental College and Hospital, JSS Academy of Higher Education and Research, Mysuru, India; E-mail: sheelagujjari@gmail.com

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Abstract

Objectives: The objective of this was to determine the of adjunctive usage of interdental mechanical aids along with educational, preventive and motivational actions on plaque reduction using Quantitative Light- induced Fluorescence (QLF-D) in motivated and non-motivated individuals.

Materials and Method: 25 dental students were selected for this study, clinical indices, and QLF-D scores were recorded for all, after which they were divided into two groups. All the participants were given standardized toothbrushes and toothpaste. One group was asked to follow the regular oral hygiene methods while the other group was asked to use toothbrushes and floss along with instructions to use them for three weeks. After said period, the participants reported to the clinic and clinical indices and QLF-D scores were recorded again. The data was collected and subjected to statistical analysis.

Results: The statistically significant intragroup difference was noted in groups. When comparing the plaque reduction three weeks post-intervention, the Simple Plaque Score (SPS) score showed a significant difference, whereas, the red fluorescence did not show any significant difference.

Conclusion: According to the results obtained, we can conclude that patient education using QLF-D was effective as interdental plaque can be visualized by the patients and effectively cleaned using interdental aids like floss, which is difficult with clinical indices alone. So QLF-D can be an effective educational and motivational tool.

Keywords: Biofilm; Interdental Plaque; Maintenance; Oral Hygiene; Quantitative Light-Induced Fluorescence

Introduction

Dental plaque is a major aetiological factor for the pathogenesis of various dental diseases like dental caries and periodontal disease. Hence, an excellent standard of oral hygiene is required to reduce the risk of developing such diseases [1]. Use of interdental aids is not common among populations; this could be attributed to an inability to visualize interdental plaque. For a clinician, assessing interdental plaque is a cumbersome process. Lange in 1986 developed the Approximal Plaque Index to measure the presence of interdental plaque, however, this index only indicates the presence or absence of plaque without providing any information on the amount of plaque accumulation. these are subjective methods of determining oral hygiene level by visual assessment and have low reliability [2].

Plaque control is mandatory to control the progression of gingivitis and periodontitis. Toothbrushing and interdental mechanical cleansing can reliably control plaque. There is weak and contradicting evidence supporting the adjunctive use of dental floss. To

this end, Quantitative Light-Induced Fluorescence (QLF) could be an alternative for plaque assessment and patient education [3]. QLF is already being used for caries detection, and monitoring effects of oral hygiene but could also be useful for interdental plaque quantification [4,5]. QLF is based on the fact, that plaque shows fluorescence in green, orange and red, if stimulated with light of specific wavelengths [6]. The intensity of red fluorescence is due to synthesized endogenous porphyrins of oral bacteria and has been shown to correlate with age and thickness of the biofilm [7]. Assessment of interdental plaque using QLF could be effective as patients will be able to visualize the presence of plaque in their mouth which would serve as a better educational guide, as compared to using only clinical indices [8]. Hence, this study was carried out to evaluate QLF as a tool for assessing interdental and evaluating the adjunctive use of interdental floss to improve the oral hygiene of dental undergraduate students.

Material and Methods

Ethical approval of this study was obtained from the Institution Ethics Committee, JSS Academy of Higher Education and Research (21/2021).

With a confidence level of 95%, margin of error of 5%, and a standard deviation of 12 (obtained from previous literature), and considering a 10% drop out rate, the sample size was estimated to be 25. The participants were selected based on the following criteria; First year undergraduate dental students (convenience, least chances of dropouts, knowledge factor) with all their permanent teeth, with normal unstimulated salivary flow rate, a habit of brushing twice daily, but do not use any interdental aids or chemical plaque control agents. Individuals free from cavitated carious lesions, Individuals wearing any orthodontic or prosthodontic appliance, Individuals with chemotherapeutic agents used during the previous two weeks and individuals with type I gingival embrasure. Individuals not willing to participate in the study, with any systemic illness or periodontitis, with history of smoking and those who are already using interdental aids were excluded from the study.

Informed written consent was taken before they participated in the study. Prior to the study, a questionnaire was given to assess the knowledge of the individuals about the use of interdental aids Baseline proximal surface plaque was collected in the morning from each sample as per following protocol.

A disposable waxed floss (Curaden) was used to collect interdental plaque. A single-trained investigator collected the interdental plaque by flossing the area between the first and second molar in each of the four quadrants. First, the interdental plaque was taken from the distal surface of the first molar, and then from the mesial surface of the second molar using another floss. The floss was passed through the contact area and below the gingival margin as deeply as possible by wrapping each tooth in a C-shape. Each side of the molar was flossed twice in the same way. The floss was removed from the interdental area by sliding its end through the dental contact point to avoid disturbing the collected plaque on its middle part. White-light and fluorescence images of the collected interdental plaque on the floss were captured immediately using QLF-D (QLF-D Billuminator, Inspector Research System, the Netherlands). Plaque scores obtained from all four quadrants were added and their average was taken as the plaque score for individual subjects [3].

The distance between the floss and the light source was kept constant, and any external light was blocked. All images were captured under the same settings (shutter speed 1/30 s, aperture value 4.5, ISO speed 1600). To quantify the Red Fluoresence of plaque observed in the acquired fluorescence images, the image analysis software (proprietary software- C3 version 1.0.0.79) was used to calculate the area and intensity. An Area Of Interest (AOI) was drawn around the boundary of the flossed area in the fluorescence image. The RF intensity was quantified by calculating the mean ratio of the red and green intensities (R/G ratio) of every pixel within the AOI. The RF area was obtained as a percentage by calculating the ratio of the number of RF pixels to the total number of the pixels within the AOI. A plaque fluorescence score was calculated by multiplying the fluorescence intensity (R/G value) and the fluorescence area (%), to represent the comprehensive fluorescence properties of the interdental plaque of each tooth [3].

The participants were given standardized compact head toothbrushes (Curaprox CS 5460), taught the Roll technique of toothbrushing using fluoridated toothpaste, along with that they were also given dental floss (Curaprox waxed dental floss), and were taught how to use the floss. These participants were given standard oral hygiene instructions. They were instructed to use them for a period of three weeks to allow them time to learn the use of dental floss.

Then the participants were randomly divided into two groups using the lottery method. The difference between the 2 groups was that, the baseline QLF images obtained for evaluating interproximal plaque, was shown to Group 2 participants as a motivational tool. After the scheduled three weeks were over, the participants were recalled and the post- intervention QLF images were repeated.

Statistical Analysis

The values were tabulated in MS Excel for statistical analysis, which was done using the SPSS software version 22. Independent samples t-test was performed, and a p value < 0.05 was considered statistically significant. The data was found to be normally distributed as it was homogeneous in nature.

Results

Of all the participants enrolled in the study, none were excluded due to lack of compliance. The intragroup comparisons of both motivated and non-motivated groups showed statistically significant improvement in SPS, R30, R60, and R120 values from baseline to 3 weeks ($p < 0.05$) (Table 1, 2). The intergroup results showed that the motivated group showed statistically significant reduction in SPS values compared to non-motivated group ($p < 0.05$). The R values also improved in motivated group compared to non-motivated group, but the difference was not statistically significant (Table 3).

		N	Mean	Std. Deviation	Mean Difference	F value	Sig
SPS	Pre-intervention	25	4.24	0.88	1.88	4.654	0.036
	Post-intervention	25	2.36	1.15			
R30	Pre-intervention	25	16.16	19.05	13.95	31.036	0.000
	Post-intervention	25	2.22	2.23			
R60	Pre-intervention	25	10.28	16.00	9.596	31.639	0.000
	Post-intervention	25	.69	0.61			
R120	Pre-intervention	25	7.18	12.74	6.71	29.788	0.000
	Post-intervention	25	.47	0.467			

Table 1: Comparison of plaque scores in non-motivated group (Group 1).

		N	Mean	Std. Deviation	Mean Difference	F value	Sig
SPS	Pre-intervention	25	4.360	0.8602	3.1200	4.99	0.030
	Post-intervention	25	1.240	0.7234			
R30	Pre-intervention	25	18.101	19.0044	17.1762	38.50	0.000
	Post-intervention	25	.925	1.1955			
R60	Pre-intervention	25	12.070	17.1843	11.8609	44.35	0.000
	Post-intervention	25	.209	0.3618			
R120	Pre-intervention	25	9.042	14.8374	8.8253	42.87	0.000
	Post-intervention	25	.216	.3908			

Table 2: Comparison of plaque scores in motivated group (Group 2).

		N	Mean	Std. Deviation	Mean Difference	F value	Sig
SPS	Non-motivated group	25	1.880	1.6911	-1.2400	4.302	0.043
	Motivated group	25	3.120	1.1299			
R30	Non-motivated group	25	13.946	19.8645	-3.2295	0.035	0.852
	Motivated group	25	17.176	18.6776			
R60	Non-motivated group	25	9.596	16.2379	-2.2680	0.200	0.657
	Motivated group	25	11.865	17.0392			
R120	Non-motivated group	25	6.709	12.8993	-2.2034	0.759	0.388
	Motivated group	25	8.913	14.8044			

Table 3: Intergroup comparison of plaque score reduction 3 weeks after intervention.

Discussion

Plaque accumulation is one of the most important etiologic factors for dental caries and periodontal diseases. Controlling plaque accumulation can go a long way in improving gingival health, thereby preventing periodontal diseases and dental caries [1]. There are various quantitative and non-quantitative methods used to assess dental plaque. Non-Quantitative methods include Plaque component of Periodontal Disease Index, Debris Index, Oral Hygiene Index, Quigley-Hein Plaque Index, Plaque Index, Glass Index, Patient Hygiene Performance Index, Turesky modified Quigley-Hein Index, Visible Plaque Index etc. Among the quantitative methods, the well-known ones are Dental Plaque weight, Planimetric indices, Quantitative Light Induced Fluorescence for Plaque Detection, Automated methods and Three-Dimensional Coordinates for Plaque Quantification. Dental plaque displays red fluorescence when exposed with red light, this fluorescence is associated with the etiological changes during plaque maturation rather than with the characteristics of single microbial species. Increased thickness, age, maturation and cariogenicity of biofilms were found to be associated with higher intensities of red fluorescence *in vitro*. This fluorescence can be used as a visual aid for motivational purposes [3].

The correlation between dental plaque indices using QLF and conventional clinical indices were correlated to assess the gingival status. It was seen that the QLF allowed objective determination of Gingival Status the authors John Bin Lee, et al., concluded that Plaque index measured by QLF-D may be used as an alternative to supplement the short coming of conventional clinical indices for educating patients about plaque control. In this present study, we found that QLF is a good educative tool.

In the present study, first year undergraduates were chosen as the test participants, owing to their lack of knowledge of interdental aids, as was reported by Gupta, et al., [9]. Those students were selected who were not already using interdental aids, such students were educated and motivated towards regular use of interdental aids, following which, a statistically significant reduction in plaque scores was observed among the participants in both groups, after using dental floss along with toothbrush, this was in accordance with a study conducted by Muralidharan, et al., in 2019, on 60 adults, concluded that motivating people to use interdental aids, can provide statistically significant results in achieving interdental plaque control, compared to using toothbrushing alone [10]. Berchier, et al., reached a similar conclusion when they conducted a systematic review to assess the adjunctive effect of flossing and toothbrushing, compared to toothbrushing alone [11].

Knowledge and practice of interdental aids was studied by Darshana Bennadi, et al., and it was seen that the overall knowledge of interdental aids among dental students were good even though deficits in few areas were noted similar to this study. When the post interventional plaque scores of both groups were compared, the group who were provided with visual motivation with the use of QLF-D had better plaque scores, though this difference was not statistically significant. This was similar to a study conducted by Akifusa, et al., where they evaluated electric toothbrush with QLF-D applied visualization in its head and compared the results with an electric toothbrush without QLF-D applied visualization [12]. The results of this study, brought them to the conclusion that brushing while looking at a monitor which depicts red-auto fluorescent dental plaque, improves efficacy of dental plaque removal, compared to brushing teeth without visualization.

Conclusion

Using this method of quantifying plaque, we can conclude that looking at an image that depicts red-fluorescent dental plaque using QLF-D system can act as motivational tool for regular use of dental floss, and help people improve their oral hygiene practice, along with being used as a chairside tool on a regular basis to quantify proximal plaque.

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Ethics Approval and Consent to Participate

Ethical approval was obtained from the Institutional Ethics Committee, written informed consent form was signed by the participants before enrolling in the study.

Conflict of Interest

The authors have no conflict of interest to declare.

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