A comparison of the efficacy of two different interdental protocols around dental implants in maintenance patients: A randomized controlled trial.

By

OMONKHELE GERTRUDE NWACHUKWU

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MASTER OF DENTISTRY (M.Dent)

Division of Periodontics, Department of Dental Sciences/Surgical Services, University of Manitoba Winnipeg

ABSTRACT

BACKGROUND

Although there are multiple studies comparing the efficacy of different interdental hygiene aids on natural teeth, little or no data exists to show what method of interdental cleaning may be most effective on dental implants. The aim of this study was to compare the effectiveness of two interdental hygiene aids (an interdental brush versus dental floss) on dental implants, assessing their effects on clinical parameters that impact on implant tissue health, as well as cytokines level in peri-implant crevicular fluid.

METHOD

This was a single blind, randomized controlled trial in a single centre.32 implant patients currently under maintenance were evaluated at baseline, 3 and 6 months. One implant was studied per participant. 16 patients used dental floss while the other 16 used interdental brushes. All hygiene aids used were supplied to participants after randomized allocation. Clinical parameters evaluated include full-mouth plaque scores and full-mouth bleeding on probing, width of implant keratinized mucosa, distance of papilla from the occlusal point of prosthesis, implant probing depths, implant plaque levels and implant bleeding on probing. Peri-implant crevicular fluid samples were also taken and IL-2,IL-4,1L-6,1L-6,1L-10,TNF-alpha and IFN-gamma levels were measured.

RESULTS

The mean and median values of all clinical variables and cytokines for both groups were calculated and compared analytically. A repeated measures analysis to compare group-time interaction was also carried out. There were reductions from baseline to 6 months in most variables for both groups. While most results were not statistically significant, there was an increase in mean probing depth of interdental brush group at 6 months for the distobuccal (0.4mm) and lingual (0.25mm) implant surfaces that was statistically significant.

CONCLUSION

Although floss slightly outperformed interdental brushes in implant plaque index and full mouth bleeding scores, other indices showed relatively comparative values between the two groups. We were unable to reject the null hypothesis as determined within the limits of these 6-months results.

INTRODUCTION

Dental Implants are an important treatment modality in rehabilitation of edentulous or partially dentate patients. According to the American Association of implant dentistry, it is estimated that 3 million Americans have implants and that number is growing by 500,000 a year.

Maintenance of an implant is absolutely crucial in order to prevent complications like peri-implant mucositis or peri-implantitis, which could culminate in loss of the implant. Implants are a huge financial undertaking and it is important that the patient attends regular maintenance appointments and be properly motivated to ensure thorough implant hygiene practices at home.

There exists a complex ecological system in the oral cavity. The oral bacteria form complex biofilm communities which can attach to a tooth or implant surface with release of virulent factors. The peri-implant crevice is usually deeper than the gingival crevice of natural teeth, and may make it more susceptible to bacterial penetration (Belibasakis et al, 2015). It is therefore important that the plaque and bacterial biofilm be regularly disrupted by toothbrushing, interdental cleaning and scaling of the implant surface.

Interdental cleaning is an integral component of home plaque control. These are often the areas of ineffective plaque control and usually where probing depths are the deepest (Loos et al, 1988; Loos et al, 1989). Studies have shown that the toothbrush alone is insufficient at removing all interproximal plaque, and therefore patients need to resort to additional techniques for maintenance of interdental health (Imai P. et al 2012; Sambujak et al 2011; Slot et al 2008).

There are various methods available for interdental cleaning around implants. No one method is suitable for all patients. The effectiveness of the method used depends largely on the ease of use and patient motivation.

Although there is a pool of studies comparing the efficacy of different interproximal tools in the natural dentition (Chiongcharoen et al, 2012; Jordan et al, 2013; Larsen et al,2016) ,there is very little ,if any, data about the most effective way to remove interproximal plaque around dental implants.

While some studies have found differences in the effectiveness of interdental brushes versus dental floss on natural teeth (Slot et al, 2008; Rasines G, 2009;Christou et al 1998), other studies did not find any difference between the two methods (Poklekovic et al 2013 ; Noorlin & Watts 2007). It is therefore necessary to evaluate what method of interdental hygiene aid may be most beneficial in improving clinical parameters and maintain a healthy implant. Assessment of anti and pro-inflammatory cytokines in the peri-implant fluid may also be of benefit.

Cytokines are proteins and glycoproteins produced by immune defence cells such as T –lymphocytes, monocytes, etc. They may also be produced by fibroblasts, epithelial and endothelial cells.
During inflammation, there is an increase in the level of these inflammatory cytokines around the peri-implant tissues and this can be used as a qualitative/ quantitative method of analysing peri-implant inflammatory disease. (Salvi et al. 2012; Pontoriero et al. 1994). The analysis of the levels of proinflammatory cytokines may be an important predictor of disease activity around an implant. Several studies have reported the usefulness of increased cytokine levels as markers for peri-implant disease (Liskmann et al, 2006;Lopez et al, 2006 ;Schierano et al 2000 ;Salcetti et al 1997)

There is thus a huge need for evidence to confirm if there is any difference between use of interdental brushes or dental floss as an adjunct to toothbrushing on dental implants. It is important to have scientific evidence through which we can make recommendations to implant patients regarding what form of interdental hygiene care would be most appropriate, not just in removing interdental plaque, but also how it might affect other clinical parameters like pocket depths, bleeding on probing and amount of keratinized tissue.

AIM

The aim of this trial was to compare the effectiveness of two interdental hygiene aids (an interdental brush versus a dental floss) on dental implant, assessing their effects on clinical parameters that impact on implant tissue health, as well as cytokines level in peri-implant crevicular fluid and perceived pain/discomfort over a one year period on dental implant patients .

MATERIALS /METHODS

STUDY DESIGN

This was a randomized, controlled trial in a single centre. All clinical measurements were taken by a single, calibrated, blinded investigator, while a single, calibrated dental hygienist was responsible for prophylaxis and delivery of oral hygiene instructions to all study participants. The results from baseline up to the 6-month visit are reported in this paper.

PARTICIPANT SCREENING

Participants were recruited from the Graduate Periodontics Clinic, University of Manitoba. The inclusion criteria of this clinical trial include participants should have one single dental implant or splinted implants, implant probing depths ≤ 5 mm, participants should have no scaling/root planing in the last three months prior to start of study and participants must be on a maintenance program at the Periodontics Graduate Clinic, University of Manitoba.

Exclusion criteria of the study were the use of anti-inflammatory medications, or antibiotics within the preceding 3 months, Non-compliant patients or patients with extensive implant prostheses, the presence of systemic conditions that may compromise host immunity (e.g. uncontrolled diabetes mellitus), participants with limited manual dexterity or inability to use a manual tooth brush.

Participants were advised that any medication which may affect plaque and inflammatory parameters e.g. mouthrinses, NSAIDS, must be avoided during the duration of the clinical trial. Ethical approval was received from

the Health Research Ethics Board, Bannatyne Campus, University of Manitoba and written informed consent was obtained from all participants.

A total of 32 participants (19 females, 13 males) with age ranging from 38 -79 years were recruited in the study. One single implant per participant was selected for assessment (6 sites per implant), and 32 implants (196 sites) in total were assessed.

BLINDING

A single, calibrated investigator took all measurements. This investigator was a Periodontics Resident at the University of Manitoba. Blinding was achieved by using codes for each participant, with the investigator being unaware of what group the participant belonged to throughout the duration of the study.

RANDOMISATION

Subjects were assigned codes at the beginning of the study and randomly assigned to two groups by a research coordinator using simple randomization.

Group Floss: 16 participants were assigned the use of floss (TePe bridge and implant floss; TePe Munhygienprodukter AB, Sweden) for implant home care and a single implant was selected from each participant to be assessed.

Group Brush: also consisted of 16 participants and they were assigned the use of Tepe interdental brush (; TePe Munhygienprodukter AB, Sweden) for implant home care. Again, a single implant was selected from each participant to be assessed.

STUDY DURATION

During the clinical trial, all participants were seen every 3 months for a one year period. All participants were invited for a baseline , 3 months ,6 months , 9 months and 12 months appointment. The results from baseline up to the 6-month visit are reported in this paper. During each tri-monthly appointment, the study investigator measured

all the clinical variables after which the participants received OHI and SPT by a single, calibrated dental hygienist (on the same appointment day). The OHI and SPT were standardized for all study participants.

At each appointment seven clinical parameters were recorded. After use of a disclosing solution, Full mouth plaque score (FMPS) was evaluated. The presence of dental plaque was evaluated on 6 surfaces (distobuccal, buccal, mesiobuccal, distolingual, lingual and mesiolingual) of all teeth and implants in the mouth. The positive plaque surfaces were then expressed as a percentage.

Next, the amount of plaque on the buccal and lingual surfaces of the study implant was assessed using the Turesky modification of the Quigley-Hein plaque index (QHI: Quigley Hein 1962,Tureskey et al. 1970) (0 –no plaque, 1 - Separate flecks of plaque at the cervical margin of the tooth , 2 - A thin continuos band of plaque (up to one mm) at the cervical margin of the tooth, 3- A band of plaque wider than one mm but covering less than one-third of the crown of the tooth, 4- Plaque covering at least one-third but less than two-thirds of the crown of the tooth , 5- plaque covering two-thirds or more of the crown of the tooth). Participants with grades 0,1 were placed in a “low-plaque “category, while participants with grades 2,3,4 were categorized as “high plaque”.

Probing depths (PD) of the study implant were recorded at six sites (distobuccal, mid-buccal, mesiobuccal, distolingual, mid- lingual and mesiolingual) to the nearest mm using a UNC 12 Colorvue® probe.

Bleeding on probing (BOP) was also assessed at the same 6 sites of the study implant (distobuccal, mid-buccal, mesiobuccal, distolingual, mid- lingual and mesiolingual) using the modified Sulcus Bleeding Index(Mombelli et al 2007) .The bleeding was graded: 0 = no bleeding, 1 = point of bleeding, 2 = line of bleeding, 3 = drop of bleeding -interdental triangle filled with blood after probing. The presence/absence of suppuration was also noted.

The width of keratinized tissue at the buccal surface of the study implant (mm) was measured. The distance from gingival margin to the most occlusal point of the implant prosthesis was measured in mm ,on both the mesial and the distal papilla.

Full mouth bleeding on probing scores (BOP) was measured as the presence of bleeding on six sites per teeth/implants and expressed as a percentage using the Gingival Bleeding Index (Ainamo & Bay, 1975).

Immediately after recording of clinical parameters, the participants met with a single, calibrated dental hygienist. The participants all received a thorough prophylaxis and detailed oral hygiene instructions. All participants received a standardized toothbrush (TePe^{R} manual toothbrush; TePe Munhygienprodukter AB,Sweden) and toothpaste (Colgate Cavity Protection toothpaste; Colgate-Palmolive Canada Inc, Toronto, Canada) ,plus their randomly assigned interdental hygiene product. All participants were instructed in the Modified Bass toothbrushing technique twice daily, morning and night for two minutes at a time. Group Floss were instructed to floss once daily, preferably at nighttime using the Tepe Bridge and Implant Floss^{R} . Group Brush were instructed in the use of Interdental brush(TePe Interdental brushes^{R}) from the facial surfaces interproximally once daily, preferably at nighttime.

Participants were all instructed to use only the hygiene aids given, and to avoid mouthwashes or use of other hygiene aids not supplied by the study. Participants were given adequate hygiene supplies to last for the duration of the study, and were able to request more supplies at any time point in the study if required.

At each visit (baseline, 3 months, 6 months), the same measurements were taken by a single investigator, and a single dental hygienist performed thorough prophylaxis and reinforcement of oral hygiene instructions. At the 12-month visit, a pain questionnaire was administered and the results of that are discussed in another paper.

PERI-IMPLANT CREVICULAR FLUID SAMPLING

Peri-implant crevicular fluid was collected from four sites of the study implant (buccal, mesial, distal and lingual) using paper strips (Periopaper; Oraflow Inc., Plainview, NY, USA) and a deep,intra-crevicular sampling technique(Insertion into the crevice until a minimum form of resistance is felt). This was done at the baseline, 3, 6 and 12 months appointments. The samples were taken immediately after plaque scores had been recorded and before any probing or other clinical variables were measured. The area was first isolated with cotton wool rolls to prevent salivary contamination and supragingival plaque was removed with hand scalers. The study site was gently air-

dried using an air-water syringe. The paper strips were then gently inserted into the implant sulcus and left in place for 30 seconds. Strips that were contaminated with blood were discarded and a new sample taken. Individual strips were placed into coded eppendorf tubes and stored at -80 degrees centigrade until required for analysis.

MEASUREMENT OF lL-2, IL-4, IL-6, IL-8, 1L-10, TNFa, IFN -gamma

The peri-implant crevicular fluid was analysed to determine the levels of IL-2, IL-4, IL-6, IL-8, IL-10, TNFa and IFN-gamma. Measurements were carried out using V-PLEX human cytokine 30-PLEX kit according to the manufacturer's guidelines.

STATISTICAL ANALYSIS

Statistical analysis was carried out using SAS version 9.3 (SAS Institute, Cary NC). Analysis of all clinical variables was computed with parametric tests for each variable at baseline, 3 and 6 months. The data for the cytokines was skewed; therefore a log-transformation was carried out to ensure normality of cytokine data before analysis.

A repeated measures analysis was carried out for both groups from baseline to 6 months using PROC MIXED. A group-by-time interaction was also computed and Tests of effect slices to compare differences between the groups at each time point was performed. P values of <0.05 were accepted as statistically significant for all analysis.

RESULTS

A total of 32 participants (19 females, 13 males) participated in this clinical trial. Interdental brush group had 16 patients comprising of 16 implants and 96 sites (6 sites per implant) with participant age ranging from 43 -79years, and floss group also had 16 patients comprising of 16 implants and 96 sites (6 sites per implant) with participant ages ranging from 38 -79years. The demographics for the study population are presented in *Table 1.* Two study

participants did not attend the three-month visit due to scheduling conflicts. There were no adverse events reported by any of the study participants as a result of the study.

TABLE 1 : DEMOGRAPHICS OF STUDY POPULATION

Total Sample Size, N =32			
		FLOSS N =16	**INTERDENTAL BRUSH N=16**
AGE (years)	MEAN (STD)	64.4(11.5)	65.9(.9)
	MINIMUM	38	43
	MAXIMUM	79	79
GENDER	MALE	4	9
	FEMALE	12	7
SMOKING	NON-SMOKER	15	15
	SMOKER	1	1

Figure 1: Consort flow chart

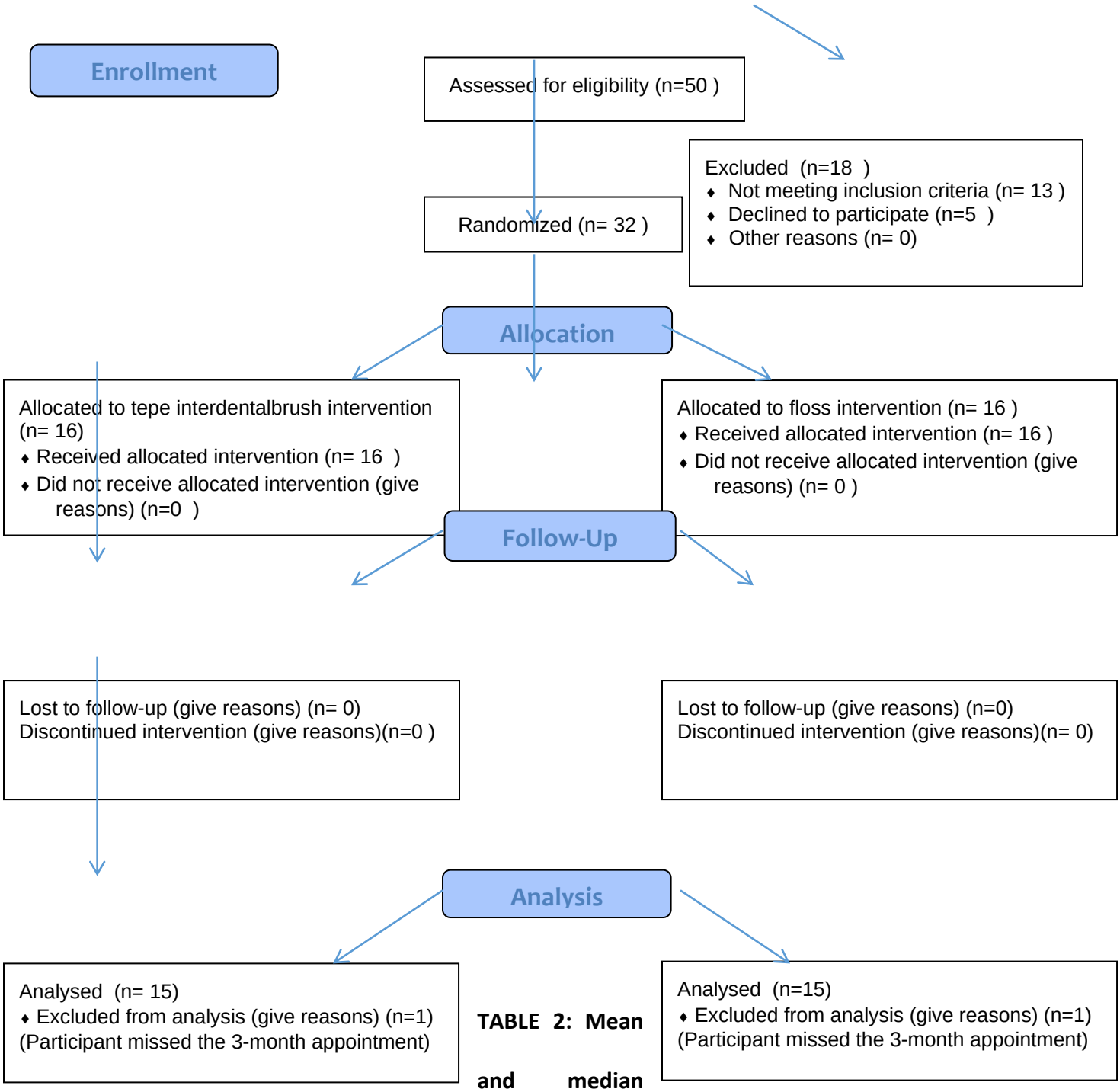

TABLE 2: Mean and median values for clinical variables measured at baseline, 3 and 6 months

VARIABLE	GROUP	BASELINE		3 MONTHS		6 MONTHS	
		MEAN (STD)	**MEDIAN**	**MEAN (STD)**	**MEDIAN**	**MEAN (STD)**	**MEDIAN**
FULLMOUTH PLAQUE SCORES (%)	FLOSS	13.2 (8.9)	10.0	13.5 (8.7)	11.8	15.3 (6.3)	13.7
	BRUSH	13.4 (5.4)	12.2	16.4 (8.2)	13.9	15.9 (5.0)	17.3
FULLMOUTH BLEEDING SCORES (%)	FLOSS	8.5 (4.3)	6.3	8.3 (2.6)	8.9	7.3 (2.7)	7.2
	BRUSH	8.6 (4.4)	8.8	8.9 (3.4)	8.6	9.5 (4	8.4
WIDTH KERATINIZED MUCOSA (mm)	FLOSS	3.8 (1.5)	4.0	3.6 (1.1)	3.5	3.3 (1.2)	3
	BRUSH	3.8 (1.5)	4.0	3.3 (1.2)	3	3.3 (1.3)	3
PAPILLA DISTANCE (MESIAL) (mm)	FLOSS	6.3 (1.7)	6.3	7.0 (2.1)	7	6.6 (1.8)	6.5
	BRUSH	7.1 (2.2)	7.0	7.6 (3.1)	7	7.2 (2.7)	6.5
PAPILLA DISTANCE (DISTAL) (mm)	FLOSS	6.8 (1.2)	6.5	7.2 (1.7)	6.5	6.7 (1.7)	6
	BRUSH	7.9 (1.8)	8	8.2 (2.4)	8.5	8.0 (2.1)	8.5

The results of the clinical variables over a 6-month period are presented in *Table 3.* A look at the seven clinical variables studied in this randomized trial, showed no clinically significant differences in mean values between the two groups at baseline.

For full mouth bleeding scores, the floss group showed a slight improvement from baseline to 6 months (from 8.5% to 7.3%), while the interdental brush group had slight worsening (from 8.6 %to 9.5%).

Results for the probing depths around the study implant are also presented in a site-specific manner for the six implant surfaces assessed. Statistically significant differences in probing depths were noted between the two groups in the distobuccal and lingual surfaces of the implants. Probing depths showed slightly worsening with an increase in mean probing depth of interdental brush group from baseline to 6 months of 0.4mm (distobuccal) and 0.25mm for lingual implant surfaces at 6 months.

Comparison of full mouth plaque scores and implant bleeding index showed no statistically significant differences for both groups.

The effect of the hygiene aids on the width of peri-implant keratinized mucosa was also analysed. Both floss and interdental brush groups had similar width of keratinized mucosa on the buccal implant surface at baseline (3.8mm) which then dropped to 3.3mm at the 6-months visit for both groups. This translates to a 0.5mm increase in recession buccally after 6 months for both groups.

The effect of the interdental hygiene aids on the papilla height is also presented. The distance from the most occlusal point of the prosthesis (crown) to the tip of the papilla was measured both mesially and distally. This distance increased from baseline to 6 months in both groups, showing that interproximal hygiene aids may compress the interproximal papilla. The greatest distance was noticed at the three-month visit for both groups, and then tended to decrease at the 6-month visit. At the 6-month visit, a statistically significant difference was noted in the distal papilla of the interdental brush group.

There were clinical differences between the two groups for the study implant plaque index .The Floss group showed a larger number of participants whose plaque index decreased from a “high plaque” category to a “low-plaque”(*Table 4)*.

Table 5 shows the results of a repeated measures model, where the overall group-by-time interaction was of primary interest. No statistically significant values were revealed between the two groups.

TABLE 3: Comparison of Mean (STD) values for clinical variables measured at baseline, 3 and 6 months

	BASELINE		3-MONTHS		6-MONTHS	
VARIABLE	**GROUP**	**MEAN (STD)**	**P-VALUE**	**MEAN (STD)**	**P-VALUE**	**MEAN (STD)**	**P-VALUE**
FULLMOUTH PLAQUE SCORES (%)	FLOSS BRUSH	13.2 98.9) 13.4 (5.3)	0.9371	13.5 (8.7) 16.4 (8.2)	0.4177	15.3 (6.3) 15.9 (5.0)	0.7886
FULLMOUTH BLEEDING SCORES (%)	FLOSS BRUSH	8.5 (4.3) 8.6 (4.4)	0.9769	8.3 (2.6) 8.9 (3.4)	0.6658	7.3 (2.7) 9.5 (4.0)	0.1022
WIDTH KERATINIZED MUCOSA (mm)	FLOSS BRUSH	3.8 (1.5) 3.8 (1.5)	1.000	3.6 (1.1) 3.3 (1.2)	0.4440	3.3 (1.2) 3.3 (1.3)	0.8280
PAPILLA DISTANCE (MESIAL) (mm)	FLOSS BRUSH	6.3 (1.7) 7.1 (2.2)	0.3186	7.0 (2.1) 7.6 (3.1)	0.4169	6.6 (1.8) 7.2 (2.7)	0.4473

PAPILLA DISTANCE (DISTAL) (mm)	FLOSS	6.8 (1.2)	0.0894	7.2 (1.7)	0.1151	6.7 (1.7)	0.0429*
	BRUSH	7.9 (1.8)		8.2 (2.4)		8.0 (2.1)	
STUDY IMPLANT PROBING DEPTH (mm)							
DISTOBUCCAL	FLOSS	2.94 (0.25)	0.1066	3.2 (0.68)	0.1805	3.06 (0.68)	0.0325*
	BRUSH	3.31 (0.70)		3.53 (0.74)		3.56 (0.73)	
BUCCAL	FLOSS	2.44 (0.89)	0.1350	2.5 (0.64)	0.8621	2.38 (0.62)	0.2834
	BRUSH	2.87 (0.96)		2.47 (0.92)		2.69 (0.79)	
MESIOBUCCAL	FLOSS	3.31 (0.79)	0.1705	3.00 (0.85)	0.3826	3.13 (0.62)	0.4306
	BRUSH	3.75 (1.00)		3.33 (1.05)		3.38 (1.03)	
DISTOLINGUAL						3.19	

	FLOSS	3.06 (0.44)	0.8031	2.8 (0.68)	0.0830	(0.91)	0.8031
	BRUSH	3.13 (0.62)		3.27 (0.88)		3.13 (0.62)	
LINGUAL	FLOSS	2.56 (0.51)	0.7684	2.27 (0.46)	0.0035*	2.44 (0.51)	0.0095*
	BRUSH	2.63 (0.72)		2.93 (0.70)		3.00 (0.63)	
MESIOLINGUAL	FLOSS	3.0 (0.63)	0.2631	2.93 (0.70)	0.1991	2.88 (0.62)	0.5747
	BRUSH	3.25 (0.58)		3.27 (0.70)		3.00 (0.52)	

**Statistically significant values*

TABLE 4: Table showing the Study implant plaque levels (categorized as low plaque or high plaque) on buccal and lingual surfaces at baseline, 3 and 6 months.

		LINGUAL		BUCCAL	
		FLOSS (N=16)	**ID BRUSH (N=16)**	**FLOSS (N=16)**	**ID BRUSH (N=16)**
BASELINE	**LOW PLAQUE (0, 1)**	13	12	9	11
	HIGH PLAQUE (2,3,4)	3	4	7	5
3 MONTHS	**LOW PLAQUE (0, 1)**	14	15	7	11
	HIGH PLAQUE (2,3,4)	1	0	8	4
6 MONTHS	**LOW PLAQUE (0, 1)**	15	12	12	10
	HIGH PLAQUE (2,3,4)	1	4	4	6

* Two patients missed the three months appointment (one from each group).For 3 months visit, N=15.

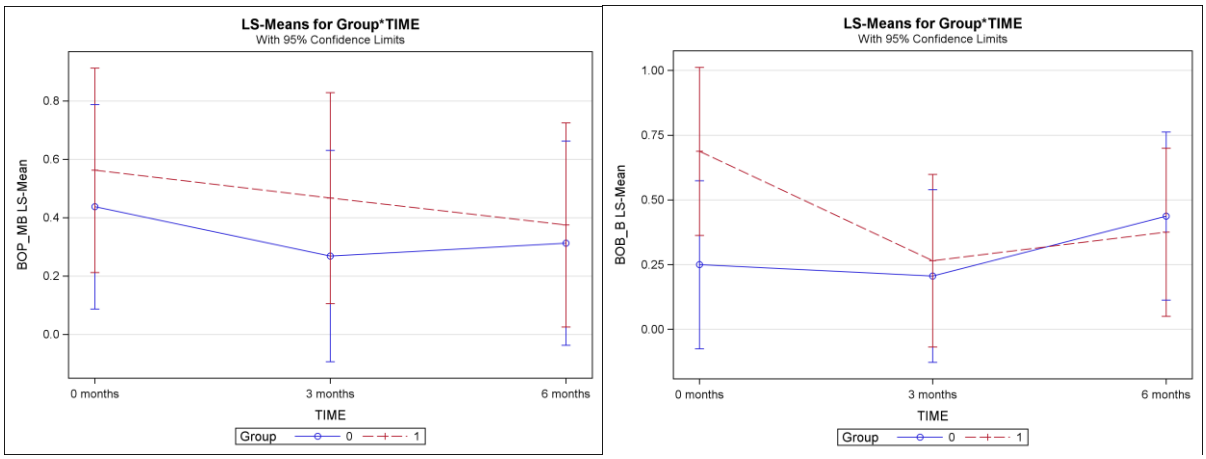

FIG 2: IMPLANT SITE SPECIFIC SURFACES SHOWING MODIFIED BLEEDING INDEX OVER TIME
0 –FLOSS 1-BRUSH

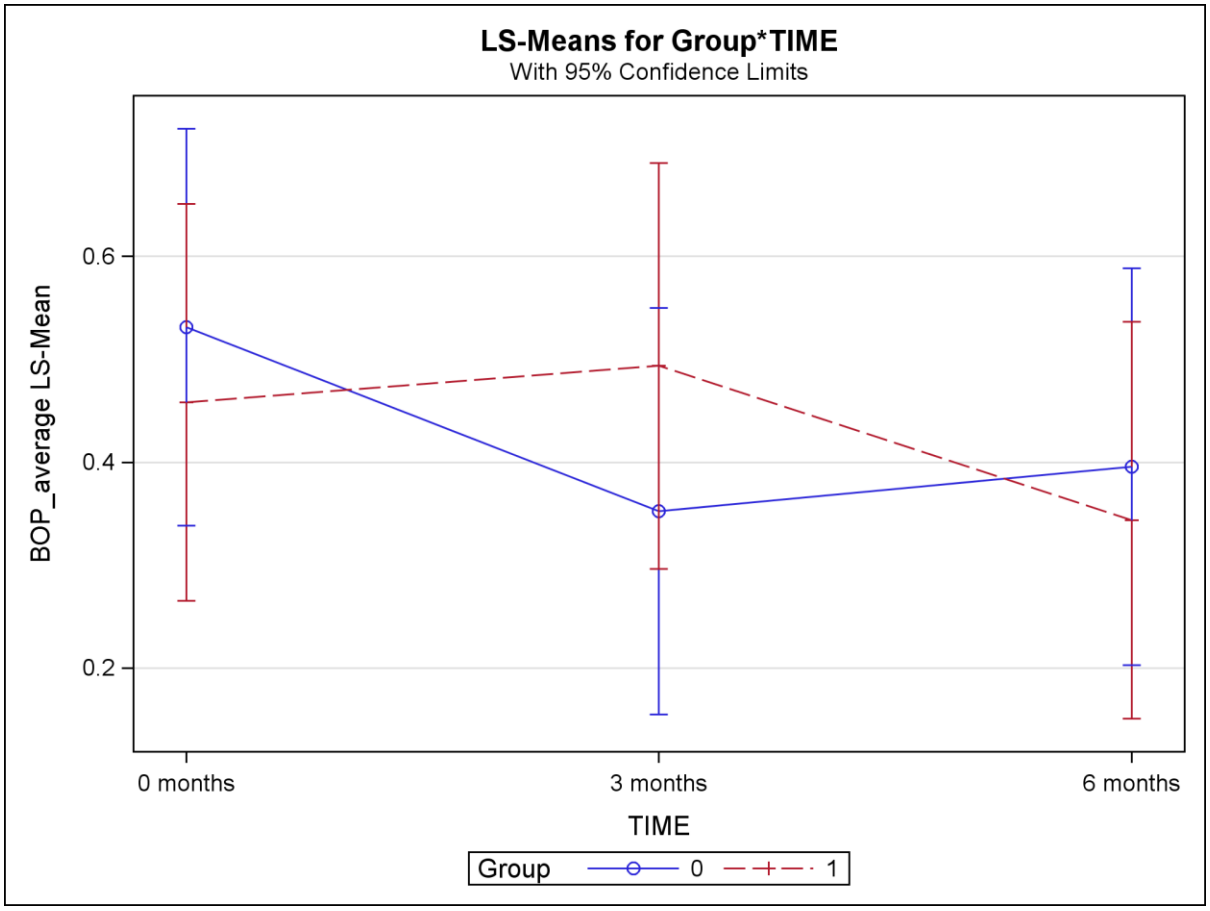

FIG 3: GROUP AVERAGES FOR MODIFIED SULCULAR BLEEDING INDEX OVER TIME
0- FLOSS 1 -BRUSH

TABLE 5: MIXED EFFECT MODELS FOR THE CLINICAL VARIABLES USING TYPE 3 TESTS OF FIXED EFFECTS.

VARIABLE	EFFECT	Num DF	Den DF	F Value	P value
STUDY IMPLANT PLAQUE INDEX **BUCCAL** **LINGUAL**	Brush_vs_Floss*TIME	 2 2	 56.4 56.4	 1.88 1.11	 0.1624 0.3363
FULL MOUTH PLAQUE SCORES	Brush_vs_Floss*TIME	2	46	0.39	0.6792
FULL MOUTH BLEEDING ON PROBING	Brush_vs_Floss*TIME	2	43.5	0.92	0.4076
STUDY IMPLANT PROBING DEPTHS **DISTOBUCCAL** **BUCCAL** **MESIOBUCCAL** **DISTOLINGUAL** **LINGUAL** **MESIOLINGUAL**	Brush_vs_Floss*TIME	 2 2 2 2 2 2	 60.4 56.9 58.2 60.9 57.8 57.4	 0.20 2.11 0.23 1.51 2.93 0.18	 0.8233 0.1300 0.7962 0.2287 0.0612 0.8384
STUDY IMPLANT BLEEDING ON PROBING	Brush_vs_Floss*TIME	2	57.8	1.51	0.2292
WIDTH OF KERATINISED PERI-IMPLANT MUCOSA	Brush_vs_Floss*TIME	2	47.7	1.45	0.2448
MESIAL PAPILLA DISTANCE	Brush_vs_Floss*TIME	2	58.9	0.07	0.9297
DISTAL PAPILLA DISTANCE	Brush_vs_Floss*TIME	2	59	0.24	0.7911

TABLE 6: COMPARISON OF MEAN /MEDIAN VALUES OF CYTOKINES FOR BOTH GROUPS OVER TIME

BASELINE	3 MONTHS	6 MONTHS

CYTOKINE (pg)	GROUP	MEAN	MEDIAN	P-VALUE	MEAN	MEDIAN	P-VALUE	MEAN	MEDIAN	P-VALUE
1L-2	FLOSS	6.96	4.58		13.33	4.14		4.83	2.96	
	BRUSH	7.42	4.62	0.50	8.39	4.75	0.54	6.44	4.15	0.46
1L-4	FLOSS	8.88	5.72		6.99	4.18		5.57	4.92	
	BRUSH	8.21	5.50	0.890	7.38	4.40	0.931	25.80	4.77	0.262
1L-6	FLOSS	166.6	11.75		15.17	5.52		21.16	10.28	
	BRUSH	40.38	17.7	0.579	71.23	8.38	0.356	81.88	7.36	0.696
1L-8	FLOSS	43028.3	25018.3		11361.0	7784.26		14047.0	9173.0	
	BRUSH	52489.5	36789.7	0.467	50435.4	10213.6	0.059	24951.5	14460.8	0.090
1L-10	FLOSS	100.72	33.50		49.58	13.99		27.89	13.04	
	BRUSH	78.68	40.61	0.425	89.39	28.26	0.016*	43.93	22.79	0.155
TNF-alpha	FLOSS	87.33	30.75		36.92	18.19		51.57	17.82	
	BRUSH	84.54	28.84	0.918	100.81	30.71	0.087	129.80	25.65	0.343
IFN_ gamma	FLOSS	140.55	41.62		66.55	55.90		296.36	38.28	
	BRUSH	351.67	64.02	0.615	76.11	51.62	0.449	248.73	46.77	0.611

The results of the cytokine measurements are detailed in *Table 6*. The cytokine data was skewed and was log-transformed before data analysis. The levels of the proinflammatory cytokines (IL-2, IL-6, IL-8, tumor necrosis factor-alpha and interferon-gamma) showed a tendency to decrease over time for both groups, but this was not statistically significant. For the anti-inflammatory cytokine (IL-10), statistically significant changes were seen at the three-months visit.

DISCUSSION

The removal of interproximal plaque around implants is necessary for the maintenance of implant health and prevention of peri-implant diseases. Our study focused on the effects of dental floss versus interdental brushes, evaluating their ability to maintain implant health. The American Academy of Periodontology describes poor plaque control with inability to clean properly as a major risk factors for peri-implant mucositis and peri-implantitis in their 2013 report. Patients with implants need to be informed about the risk of peri- implant disease and be instructed in proper implant hygiene practices. Home care oral hygiene regimes are thus an important aspect of short and long term dental implant survival and success.

Studies have shown that the toothbrush alone is ineffective in plaque removal in interdental areas (Sambujak et al, 2011) and these interdental areas are usually the sites more likely to have gingival inflammation with deeper pocket depths.

Various forms of interdental hygiene aids are available and they include interdental brushes, floss, wooden sticks, plastic sticks and oral irrigation devices.

Floss is the most widely used method of interdental cleaning in North America and the American Dental Association reports that up to 80% of interdental plaque may be removed by this method.

Individuals may have difficulty with flossing techniques (Asadoorian, 2006) and may find other methods of interdental cleaning preferable. Interdental brushes come in various sizes and are usually composed of nylon filaments twisted on a fine, stainless steel wire. They are usually conical or cylindrical in cross-section, but triangular cross-section interdental brushes are also available (Slot et al, 2008; Dorfer et al, 1997).

Multiple studies on natural teeth have been carried out to determine the efficacy of interdental brushes compared to dental floss in the removal of interdental plaque, and associated parameters like reduction in probing depths and bleeding on probing.

The attempts made to compare the results of our study to the most representative studies currently available, was quite problematic. To our knowledge, there is very little, if any, literature comparing efficacy of dental floss and interdental brushes on dental implants. Attempts were made to compare our study with studies that looked at interdental cleaning aids on natural teeth but this presented some challenges due to differences in study design, differences in study duration, types of clinical indices analysed, types of interdental hygiene aids used in the studies and differences in the frequencies of maintenance appointments.

We evaluated how the type of interdental hygiene aid would affect the interdental papilla. This was done by measuring the distance from the tip of the papilla to the most occlusal point of the prosthesis; both on the mesial and distal implant surfaces. For the mesial papilla on the study implant, the floss group had an increase in distance at the 3-month appointment of 0.7mm, while interdental brush group had an increase of 0.5mm at the 3-month visit. This is in agreement with results from a study on natural teeth (Jackson et al, 2006). This shrinkage in papilla height may be associated with reduction of oedematous soft tissue swelling from decreased inflammation, as well as possible compression of the papilla by the interdental hygiene aid. At the six-month appointment for both groups, the distance had decreased somewhat, but was not statistically significant. When the distal papilla was evaluated, we found the same trend. At three months, there was an increased distance for both floss (0.4mm) and interdental brush (0.3mm) group. At 6 months, the distance had decreased and this was statistically significant for the interdental brush group. Jackson et al (2006) conducted a single blind, randomized trial on seventy-seven patients to check the differences between floss and interdental brushes on chronic periodontitis patients. The authors evaluated the distance from the tip of the papilla, to the most occlusal edge of the tooth and found an increase distance by 12-weeks of 0.99mm in the brush group and 0.59mm in the floss group.

Full mouth plaque scores and full mouth bleeding scores were analysed for the two groups. We did not find any appreciable statistical significant differences between the two groups. Although the mean full mouth bleeding scores

were similar at baseline for both groups, the floss group had a 1.2 % decrease in bleeding scores at 6 months, while the interdental brush group showed a 1% increase in bleeding scores at the 6-month appointment.

The mean full mouth plaque and bleeding scores for both study groups over the six month period was always less than 20%. This maintenance of good oral hygiene may be explained by the fact that patients had a thorough prophylaxis and oral hygiene instructions by a well trained hygienist at the baseline,3 months and 6 months appointment. The removal of the plaque biofilm and elimination of potentially periodontopathic organisms is reflected in the low mean plaque and bleeding scores. . Patients were motivated to achieve stellar home-care oral hygiene. Prophylaxis was received at every visit and oral hygiene instructions reinforced This constant disruption of the plaque bio-film would have helped to maintain the balance in the oral flaura and might explain why both mean full mouth plaque and bleeding scores were less than 20% in our study at every time point. Studies have shown that a 3-monthly maintenance regimen is sufficient for maintenance of periodontal health (Eccheverria et al 1996; Caton et al, 1982)

The Hawthorne effect may have also played a role in the low plaque levels observed from the study participants in our clinical trial.

When the study implants were assessed using the Turesky modification of the Quigley-Hein plaque index, there was a reduction in the number of participants in the high plaque category over the 6 months period for both groups. This reduction in plaque was greater in the floss group. Though clinically significant, it was not statistically significant. This is similar to the findings reported by Imai and Hatzimanolakis (2010). Their study was an examiner blinded, randomized, split mouth 12-week trial on 30 volunteers comparing dental floss to interdental brushes on natural teeth. The authors demonstrated that the use of floss or interdental brushes clinically reduced plaque, but their results were also not statistically significant.

We used a repeated measures model to make comparisons between floss and interdental brushes over time. We conducted “Type 3 tests of fixed effects” using PROC MIXED software to determine a group-by-time –interaction

effect and a test of effect slices was also conducted to compare the floss and interdental brush groups at each time period (baseline, 3 months and 6 months). We did not find statistically significant differences (Table 5) in the floss versus interdental group over time.

Similar conclusions were reported by Noorlin & Watts (2007). Their split mouth study was on 10 patients with mild to moderate periodontitis over a one-month period. Dental floss was used on one half of the mouth while interdental brushes were used on the other side of the mouth. The authors compared changes in plaque scores, bleeding on probing and pocket depth reduction. Results showed reduction in interproximal plaque, bleeding on probing and pocket depth reduction for both dental floss and interdental brushes. There were no significant differences in results for dental floss or interdental brushes. Both interdental hygiene methods reported similar beneficial effects on interdental health. The study participants however reported a preference for interdental brushes due to ease of use. It is important to note that smokers were excluded from this study as it could have been an important co-founding factor. Poklekovic et al (2013) also conducted a systematic review to determine the efficacy of interdental brushes as an adjunct to toothbrushing compared to dental floss as an adjunct to toothbrushing compared to toothbrushing alone. The authors found insufficient evidence to determine whether interdental brushing was more effective than dental flossing in the removal of interdental plaque and reduction of interproximal gingivitis on natural teeth.

The peri-implant crevicular fluid is an exudate within the implant sulcus or crevice. It contains inflammatory mediators, tissue break down products and antibodies directed against oral bacteria (Adonogianaki 1995). Analysis of this fluid is an important way of determining the inflammatory processes occurring around an implant, and may be an important marker for monitoring peri-implant health. While many cytokines in the peri-implant crevicular fluid are proinflammatory (for example IL-1, 1L-2,IL-6), several anti-inflammatory cytokines also exist. IL-10 is one of the anti-inflammatory cytokines and it has been shown to inhibit the production of various proinflammatory cytokines including IL-1, IL-2, IL-6, IL-8, tumor necrosis factor-alpha and interferon-gamma.

In our study, the levels of the proinflammatory cytokines (IL-2, IL-6, IL-8, tumor necrosis factor-alpha and interferon-gamma) showed a tendency to decrease over time for both groups, but this was not statistically significant. A systematic review by Candel-Marti et al (2011) evaluated the levels of IL-6,1L-8, 1L-10,1L-12 and their influence upon dental implant osseointegration and peri-implant disease. The authors concluded that while an increase in the levels of these cytokines were noted in sites with peri-implant disease ,there is still controversy regarding a direct causal effect or association to implant failure.

Other studies have shown no relationship between interleukins and peri-implant disease and have disputed the theory that increased levels of these cytokines are linked to peri-implant bone loss (Duarte et al 2009; Mengel et al 1996)

CONCLUSION

The goal of this trial was to evaluate the efficacy of using either floss and interdental brushes on implant maintenance patients. Though Floss slightly outperformed interdental brushes in implant plaque index and full mouth bleeding scores, other indices showed relatively comparative values between the two groups. We were unable to reject the null hypothesis as determined within the limits of these 6-months results. Further long-term studies are required to address this issue more fully.

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