



Comparison of the Plaque Removal Efficacy of Aquajet Water Flosser and Dental Floss in Adults After a Single Use. (A Preliminary Study)

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ABSTRACT

Background and Aim: Toothbrushes cannot reach all interdental areas. Interdental cleaning is an important part of oral hygiene care. The purpose of this study was to compare the supragingival plaque removal efficacy of an interdental cleaning power device (Aquajet) and dental floss.

Methods and Materials: Thirty subjects were enrolled in this single-blind, split mouth clinical trial. All the subjects received both written and verbal instructions and demonstrated proficiency prior to the study. The subjects were asked to abstain from oral hygiene methods for 48 hours prior to the study. The subjects were scored using the Proximal/Marginal Plaque Index (PMI). Then, the four oral quadrants were randomly assigned to one of two treatment groups: One upper and one lower quadrant: Aquajet and the other two quadrants: dental floss. The subjects were observed to ensure that they have covered all areas and have followed the instructions. Afterwards, they were scored again using the PMI. The pre and post-cleaning plaque scores were evaluated using two-way repeated measure ANOVA.

Results: Both Aquajet and dental floss showed significant reduction of the baseline PMI in all dental areas ($P < 0.05$), but the difference between the groups was not significant ($P > 0.05$). Aquajet was significantly more effective than dental floss in reducing plaque on the mesial, mid-buccal and distal surfaces of upper first premolar and on the mesial and distal surfaces of upper second premolar and first molar ($P < 0.05$).

Conclusion: The results proved that oral irrigation with Aquajet is as effective as that with dental floss in plaque removal, and that Aquajet had significantly higher plaque removal efficacy at hard-to-reach dental surfaces.

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Introduction:

Interdental cleaning is an important part of oral hygiene care. Tooth brushing alone cannot remove all the plaque from dental surfaces, even when done correctly and thoroughly. Dental floss is considered as the “gold standard” of interdental care⁽¹⁾, although flossing is really difficult for some patients. Data indicate that only 2% to 10% of the population floss regularly, while a major part of the population never floss.^(2, 3) Oral irrigators were invented 50 years ago, and have shown to reduce probing pocket depth, bleeding on probing, supragingival plaque and proinflammatory cytokine levels.⁽⁴⁻¹¹⁾

There are many types of oral irrigators available. Some have pressure and pulsation characteristics, while the others are continuous stream devices.⁽¹⁾ In 2005, Barnes et al reported that there was no difference between “manual tooth brush and water flosser” and “manual tooth brush and string floss” in reducing plaque biofilm.⁽⁶⁾ Lyle et al also reported that “If patients are brushing and flossing and they have no clinical, radiographic or other signs of infection, no major intervention is needed. However, if they are not flossing or have clinical signs of gingival or periodontal infection, then perhaps it is time to recommend an effective alternative such as water flosser.”⁽¹⁾

The objective of this study was to determine the plaque removal efficacy of Aquajet water flosser (introduced recently to markets in Iran) in comparison with traditional string floss.

Materials and Methods:

Thirty healthy non-smoking dental students with the average age of 26.53 ± 5.78 years were recruited for this study. All the subjects had at least 20 scorable teeth excluding third molars. The students that had orthodontic appliances, implants, crowns and bridges or other appliances were excluded from the study. The protocol of this study has been approved by the ethics committee of the dental branch of Islamic Azad University of Tehran, Iran. The subjects completed the medical history record and signed an informed consent. The ethics code of the present study is (IR.IAU.DENTAL.REC.1395,12).

Aquajet water flosser (NPB future Co., Tehran, Iran) is a battery-free water-powered device. It has a spray nozzle and no reservoir. It can be installed to faucets or wall-fixed shower heads through an adaptor (water separator). It should be noted that the water pressure can be adjusted manually. (Figure 1)

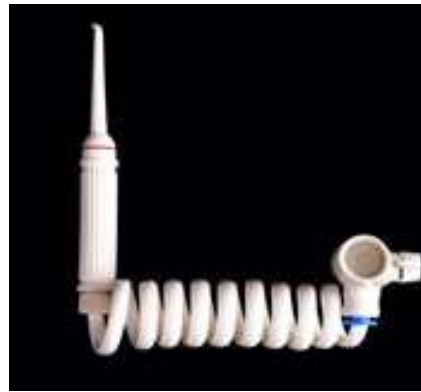


Figure 1- Aquajet water flosser (NPB future Co.).

The participants followed the manufacturer’s instructions and directed the nozzle towards the gingival margin and followed a pattern throughout the mouth.

In this randomized, single-blind, single-use, split mouth clinical trial, all the participants received both written and verbal instructions and demonstrated proficiency prior to the study. They were also instructed on how to floss correctly. (Oral B essential floss, Procter & Gamble, Geneva, Switzerland). The correct technique (wrapping the floss around the middle fingers, using the index fingers and thumb to guide the floss, contour around the side and move up and down the tooth) was communicated in writing and verbally. The subjects were asked to abstain from oral hygiene methods for 48 hours prior to their appointment. An examiner who was blinded to the products was assigned and calibrated for intra-examiner reproducibility of Proximal/Marginal Plaque Index (PMI).⁽¹²⁾. The PMI divides the buccal and lingual surfaces of each tooth into 3 unequal segments, each of which can be given a score ranging from 0 to 5 according to Turesky-Gilmore-Glickman modification of the Quigley-

Hein plaque index. (0= No Plaque, 1= Separate flecks of plaque covering less than 1/3 of the area, 2= Discrete areas or bands of plaque covering less than 1/3 of the area, 3= Plaque covering 1/3 of the area, 4= Plaque covering more than 1/3 but less than 2/3 of the area, and 5= Plaque covering 2/3 or more of the area).⁽¹⁴⁾ The four quadrants of the participants' mouth were randomly divided into two treatment groups: One upper and one lower quadrants were cleaned using Aquajet alone, while the other two quadrants were cleaned using dental floss alone. These two quadrants were changed from one participant to the other in a clockwise rotation. Subjects were observed to ensure they have covered all areas and have followed the instructions. Afterwards, the teeth were scored again by the same examiner using the PMI. The percentage of satisfaction with each product was recorded through interviewing the study groups.

Data were summarized using the descriptive statistics. The pre and post-cleaning plaque scores were evaluated by two-way repeated measure ANOVA. The level of significance was set at <0.05.

Results:

Both groups showed statistically significant changes from pre-cleaning to post-cleaning scores in all maxillary and mandibular teeth. (Tables 1 to 4) Aquajet was significantly more effective in plaque removal at the mesial, mid-buccal and distal surfaces of upper first premolar in comparison with dental floss ($P=0.035$, $P=0.053$ and $P=0.017$, respectively). It was also more effective than dental floss at the mesial and distal surfaces of upper second premolar ($P=0.019$ and $P=0.027$, respectively). Aquajet was also more effective in plaque removal at the mesial and distal surfaces of upper first molar ($P=0.008$ and $P=0.007$, respectively). There were no statistically significant differences between the plaque removal efficacy of these two interproximal cleaning aids at the surfaces of other maxillary teeth ($P>0.05$). There were also no statistically significant differences between pre and post-cleaning plaque index scores of Aquajet and dental floss at the mesial, mid-buccal, distal and lingual

surfaces of mandibular teeth ($P>0.05$). Maxillary and mandibular teeth were divided to four groups: (Group 1: maxillary and mandibular incisors and canines, Group 2: premolars, Group 3: first molars, and Group 4: second molars.). There were significant differences between pre and post-cleaning scores at the surfaces of maxillary premolar and first molar ($P=0.035$ and $P=0.024$, respectively). The percentage of satisfaction was 67% for Aquajet and 57% for dental floss.

Table 1- Pre and post-cleaning plaque scores (Mean±standard deviation) in maxillary teeth after using Aquajet

Tooth number	surfaces	Before	After	Difference	P-value
1	Mesial	1.92±1.03	0.83±0.67	1.09±0.45	P<0.05
	Midbuccal	1.51±0.75	0.84±0.59	0.67±0.36	
	Distal	1.74±0.89	0.87±0.74	0.87±0.41	
	Palatal	1.98±0.85	1.15±0.71	0.81±0.35	
2	Mesial	1.67±0.75	0.94±0.64	0.73±0.38	
	Midbuccal	1.59±0.60	0.81±0.56	0.78±0.29	
	Distal	1.74±0.59	0.97±0.68	0.77±0.37	
	Palatal	1.94±0.94	1.17±0.79	0.77±0.49	
3	Mesial	1.85±0.79	1.11±0.61	0.74±0.27	
	Midbuccal	1.49±0.51	0.91±0.47	0.58±0.39	
	Distal	1.98±0.83	1.25±0.78	0.73±0.38	
	Palatal	1.85±0.47	1.03±0.61	0.82±0.18	
4	Mesial	2.06±0.78	1.34±0.68	0.72±0.28	
	Midbuccal	1.87±0.51	1.09±0.49	0.78±0.26	
	Distal	2.17±0.091	1.17±0.75	1.0±0.35	
	Palatal	1.67±0.59	1.00±0.74	0.67±0.28	
5	Mesial	2.04±0.85	0.96±0.53	1.08±0.35	
	Midbuccal	1.75±0.51	0.97±0.48	0.78±0.21	
	Distal	2.07±0.92	0.99±0.65	1.08±0.34	
	Palatal	1.70±0.56	0.96±0.60	0.74±0.14	
6	Mesial	2.11±0.78	1.13±0.75	0.98±0.39	
	Midbuccal	1.89±0.81	1.09±0.64	0.8±0.28	
	Distal	2.18±0.84	1.27±0.78	0.91±0.41	
	Palatal	1.74±0.64	1.01±0.53	0.73±0.35	
7	Mesial	2.24±0.75	1.62±0.84	0.62±0.36	
	Midbuccal	2.07±0.58	1.41±0.57	0.66±0.27	
	Distal	2.27±0.91	1.47±0.75	0.8±0.58	
	Palatal	1.73±0.75	1.20±0.58	0.53±0.58	

Table 2- Pre and post-cleaning plaque scores (Mean±standard deviation) in maxillary teeth after using dental floss

Tooth number	surfaces	Before	After	Difference	P-value
1	Mesial	1.86±0.98	0.87±0.84	0.99±0.31	P<0.05
	Midbuccal	1.69±0.85	0.84±0.75	0.85±0.32	
	Distal	1.84±0.91	0.92±0.86	0.92±0.39	
	Palatal	1.94±0.97	1.09±0.84	0.85±0.40	
2	Mesial	1.69±0.84	0.81±0.87	0.88±0.40	
	Midbuccal	1.75±0.83	0.94±0.81	0.81±0.36	
	Distal	1.68±0.94	0.87±0.76	0.81±0.29	
	Palatal	1.97±0.85	1.15±0.86	0.82±0.26	
3	Mesial	1.69±0.85	0.94±0.71	0.75±0.38	
	Midbuccal	1.58±0.96	0.71±0.53	0.87±0.19	
	Distal	1.75±0.84	1.01±0.69	0.74±0.28	
	Palatal	1.92±0.64	1.07±0.75	0.85±0.48	
4	Mesial	1.85±0.72	1.20±0.85	0.65±0.37	
	Midbuccal	1.61±0.63	1.14±0.61	0.47±0.19	
	Distal	1.89±0.84	1.28±0.92	0.61±0.45	
	Palatal	1.64±0.61	1.01±0.54	0.63±0.19	
5	Mesial	1.94±0.85	1.32±0.76	0.62±0.39	
	Midbuccal	1.62±0.52	0.97±0.46	0.65±0.16	
	Distal	1.91±0.87	1.24±0.84	0.67±0.37	
	Palatal	1.68±0.72	1.05±0.58	0.63±0.21	
6	Mesial	2.14±0.75	1.50±0.70	0.64±0.41	
	Midbuccal	2.07±0.61	1.38±0.52	0.69±0.22	
	Distal	2.19±0.84	1.62±0.79	0.57±0.45	
	Palatal	1.72±0.58	1.11±0.54	0.61±0.25	
7	Mesial	2.27±0.91	1.70±0.62	0.57±0.51	
	Midbuccal	2.19±0.49	1.32±0.48	0.87±0.27	
	Distal	2.24±0.63	1.66±0.65	0.58±0.41	
	Palatal	1.75±0.68	1.24±0.59	0.51±0.24	

Table 3- Pre and post-cleaning plaque scores (Mean±standard deviation) in mandibular teeth after using Aquajet

Tooth number	surfaces	Before	After	Difference	P-value
1	Mesial	2.14±0.95	1.35±0.85	0.79±0.37	P<0.05
	Midbuccal	1.95±0.84	1.24±0.67	0.71±0.35	
	Distal	2.10±1.09	1.29±0.94	0.81±0.28	
	Lingual	1.98±1.25	1.36±1.06	0.62±0.59	
2	Mesial	2.13±0.84	1.26±0.91	0.87±0.38	
	Midbuccal	1.97±0.61	1.30±0.54	0.67±0.21	
	Distal	2.09±0.92	1.35±0.69	0.74±0.58	
	Lingual	2.10±0.98	1.38±1.28	0.72±0.76	
3	Mesial	2.06±0.97	1.28±0.84	0.78±0.39	
	Midbuccal	1.89±0.68	1.09±0.59	0.80±0.41	
	Distal	2.14±0.95	1.29±0.91	0.85±0.38	
	Lingual	1.84±0.94	1.10±0.87	0.74±0.21	
4	Mesial	2.19±1.04	1.40±0.71	0.79±0.45	
	Midbuccal	2.08±0.75	1.36±0.57	0.72±0.36	
	Distal	2.20±1.19	1.47±0.70	0.73±0.56	
	Lingual	1.79±1.06	1.06±0.80	0.73±0.35	
5	Mesial	2.26±0.97	1.51±0.75	0.75±0.51	
	Midbuccal	2.17±0.76	1.39±0.61	0.78±0.34	
	Distal	2.28±1.35	1.56±0.98	0.72±0.67	
	Lingual	2.06±1.15	1.34±0.91	0.72±0.28	
6	Mesial	2.28±1.14	1.50±0.96	0.78±0.41	
	Midbuccal	2.21±0.91	1.39±0.64	0.82±0.29	
	Distal	2.34±1.08	1.54±0.78	0.8±0.59	
	Lingual	2.24±1.24	1.56±0.78	0.68±0.24	
7	Mesial	2.35±1.08	1.68±0.78	0.67±0.40	
	Midbuccal	2.24±1.00	1.60±0.81	0.64±0.26	
	Distal	2.29±1.27	1.75±0.79	0.54±0.47	
	Lingual	2.29±1.35	1.74±0.91	0.55±0.45	

Table 4- Pre and post-cleaning plaque scores (Mean±standard deviation) in mandibular teeth after using dental floss

Tooth number	surfaces	Before	After	Difference	P-value
1	Mesial	2.07±0.91	1.29±0.90	0.78±0.36	P<0.05
	Midbuccal	1.86±0.74	1.20±0.74	0.66±0.19	
	Distal	2.13±1.06	1.24±0.95	0.89±0.28	
	Lingual l	2.04±1.14	1.50±0.78	0.54±0.45	
2	Mesial	2.14±0.78	1.30±0.65	0.84±0.47	
	Midbuccal	1.95±0.74	1.28±0.58	0.67±0.58	
	Distal	2.08±1.04	1.31±0.82	0.77±0.49	
	Lingual	2.15±1.29	1.63±1.04	0.52±0.54	
3	Mesial	2.14±1.08	1.37±0.64	0.77±0.31	
	Midbuccal	2.01±0.76	1.20±0.65	0.81±0.24	
	Distal	2.10±1.02	1.24±0.87	0.86±0.51	
	Lingual l	1.78±0.97	1.18±1.01	0.6±0.36	
4	Mesial	2.25±1.28	1.40±0.84	0.85±0.40	
	Midbuccal	2.07±0.94	1.31±0.70	0.76±0.27	
	Distal	2.18±1.06	1.41±0.95	0.77±0.24	
	Lingual	1.84±0.85	1.17±0.90	0.67±0.29	
5	Mesial	2.21±1.14	1.43±0.97	0.78±0.45	
	Midbuccal	2.09±0.97	1.35±0.65	0.74±0.25	
	Distal	2.25±1.08	1.39±1.02	0.86±0.78	
	Lingual	2.08±0.94	1.29±0.84	0.79±0.27	
6	Mesial	2.35±1.07	1.58±0.84	0.77±0.40	
	Midbuccal	2.16±0.98	1.39±0.78	0.77±0.21	
	Distal	2.39±1.04	1.62±0.84	0.77±0.59	
	Lingual	2.28±1.06	1.59±0.85	0.69±0.35	
7	Mesial	2.40±1.09	1.79±1.04	0.61±0.28	
	Midbuccal	2.28±0.85	1.71±0.87	0.57±0.18	
	Distal	2.39±1.27	1.76±1.36	0.63±0.87	
	Lingual	2.35±1.01	1.82±0.76	0.53±0.28	

Table 5- Pre and post-cleaning plaque reduction scores (Mean±standard deviation) in maxillary teeth after using Aquajet and dental floss

Tooth number	surfaces	Aquajet	Floss	P-value
1	Mesial	1.09±0.45	0.99±0.31	NS
	Midbuccal	0.67±0.36	0.85±0.32	NS
	Distal	0.87±0.41	0.92±0.39	NS
	Palatal	0.81±0.35	0.85±0.40	NS
2	Mesial	0.73±0.38	0.88±0.40	NS
	Midbuccal	0.78±0.29	0.81±0.36	NS
	Distal	0.77±0.37	0.81±0.29	NS
	Palatal	0.77±0.49	0.82±0.26	NS
3	Mesial	0.74±0.27	0.75±0.38	NS
	Midbuccal	0.58±0.39	0.87±0.19	NS
	Distal	0.73±0.38	0.74±0.28	NS
	Palatal	0.82±0.18	0.85±0.48	NS
4	Mesial	0.72±0.28	0.65±0.37	0.035
	Midbuccal	0.78±0.26	0.47±0.19	0.053
	Distal	1.0±0.35	0.61±0.45	0.017
	Palatal	0.67±0.28	0.63±0.19	NS
5	Mesial	1.08±0.35	0.62±0.39	0.019
	Midbuccal	0.78±0.21	0.65±0.16	0.078
	Distal	1.08±0.34	0.67±0.37	0.027
	Palatal	0.74±0.14	0.63±0.21	NS
6	Mesial	0.98±0.39	0.64±0.41	0.008
	Midbuccal	0.8±0.28	0.69±0.22	0.064
	Distal	0.91±0.41	0.57±0.45	0.007
	Palatal	0.73±0.35	0.61±0.25	NS
7	Mesial	0.62±0.36	0.57±0.51	0.195
	Midbuccal	0.66±0.27	0.87±0.27	0.361
	Distal	0.8±0.58	0.58±0.41	0.071
	Palatal	0.53±0.58	0.51±0.24	NS

Table 6- Pre and post-cleaning plaque reduction scores (Mean±standard deviation) in mandibular teeth after using Aquajet and dental floss

Tooth number	surfaces	Aquajet	Floss	P-value
1	Mesial	0.79±0.37	0.78±0.36	NS
	Midbuccal	0.71±0.35	0.66±0.19	NS
	Distal	0.81±0.28	0.89±0.28	NS
	Lingual	0.62±0.59	0.54±0.45	0.098
2	Mesial	0.87±0.38	0.84±0.47	NS
	Midbuccal	0.67±0.21	0.67±0.58	NS
	Distal	0.74±0.58	0.77±0.49	NS
	Lingual	0.72±0.76	0.52±0.54	0.087
3	Mesial	0.78±0.39	0.77±0.31	NS
	Midbuccal	0.80±0.41	0.81±0.24	NS
	Distal	0.85±0.38	0.86±0.51	NS
	Lingual	0.74±0.21	0.6±0.36	0.947
4	Mesial	0.79±0.45	0.85±0.40	NS
	Midbuccal	0.72±0.36	0.76±0.27	NS
	Distal	0.73±0.56	0.77±0.24	NS
	Lingual	0.73±0.35	0.67±0.29	NS
5	Mesial	0.75±0.51	0.78±0.45	NS
	Midbuccal	0.78±0.34	0.74±0.25	NS
	Distal	0.72±0.67	0.86±0.78	NS
	Lingual	0.72±0.28	0.79±0.27	NS
6	Mesial	0.78±0.41	0.77±0.40	NS
	Midbuccal	0.82±0.29	0.77±0.21	NS
	Distal	0.8±0.59	0.77±0.59	NS
	Lingual	0.68±0.24	0.69±0.35	NS
7	Mesial	0.67±0.40	0.61±0.28	NS
	Midbuccal	0.64±0.26	0.57±0.18	NS
	Distal	0.54±0.47	0.63±0.87	NS
	Lingual I	0.55±0.45	0.53±0.28	NS

Discussion:

The present study evaluated the plaque removal efficacy of Aquajet (a simple, battery-free oral irrigator with no reservoir). The results showed that this simple water flosser is more effective in reducing plaque on areas that are often difficult to floss. Individuals tend to miss the proximal and marginal dental areas. The adjunctive use of an interdental cleaner is necessary to clean the hard-to-reach interdental areas and proximal surfaces of the teeth. These areas are usually start points for infection and gingivitis. Supragingival plaque removal is important in preventing the initiation and proliferation of subgingival pathogenic bacteria. The highest levels of plaque accumulation can be observed on the disto-lingual and mesio-lingual surfaces of mandibular molars and premolars followed by the disto-buccal and mesio-buccal surfaces of maxillary and mandibular molars. In a systematic review, Berchier et al reported that the combined use of dental floss and tooth brush did not benefit gingival health improvement.⁽¹⁵⁾ There is also a systematic review by Hujoel et al that showed no evidence that flossing reduces interdental caries in adolescents.⁽¹⁶⁾ Aquajet has been introduced recently to markets in Iran. It is a hand-held device designed to deliver pressurized water directly to the interdental areas. Thus far, there are no studies available regarding the efficacy of Aquajet in reducing plaque index scores in comparison to dental floss. Therefore, in this preliminary study we only compared the plaque removal efficacy of the two mentioned interdental aids and we did not include manual tooth brushing. Each product must be assessed on its own body of evidence, as clinical studies on one product do not support the efficacy of another. Client acceptance of difficult-to-use appliances is usually low, regardless of patients' needs and the clinical results.

Client acceptance of water flosser has been examined in a few studies. Hoover et al reported that the individuals that had used water flosser stated that they had a pleasant experience and that their mouth felt cleaner.⁽¹⁷⁾ The participants of the present study were more satisfied with Aquajet water flosser in comparison

with dental floss.

Water is an effective agent which is available and has no side-effects. One of the deficiencies of Aquajet water flosser is that it does not accept mouthrinses and antibacterial agents, while most commercially-available products are designed to accept these agents.⁽³⁾

This appliance should also be tested on patients with orthodontic appliances, crowns, bridges and implants and also on diabetic patients. This study provides no clinical information on the efficacy of this type of water flosser on periodontal clinical parameters such as gingival inflammation and probing pocket depth.

Conclusions:

The results of the present study showed that:

- 1- Aquajet is well-accepted by patients.
- 2- Aquajet is as effective as string floss in reducing plaque on mandibular teeth.
- 3- Aquajet is significantly more efficient than string floss in reducing plaque in hard-to-reach areas of maxillary teeth.

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References:

1. Lyle DM. Use of Water Flosser for interdental cleaning. *Compend Contin Educ Dent* 2011; 32(9):78,80-2.
2. Sarlati F, Simdar N, Shariatmadarrahmadi R. Comparative evaluation of immediate effect of root instrumentation with curettes and mini-insert ultrasonic scalers on Clinical Attachment Level. *J Res Dentomaxillofac Sci* 2016;1(3),38-43.
3. Macgregor ID, Balding JW, Regis D. Flossing behaviour in English adolescents. *J Clin Periodontol* 1998;25(4):291-6.
4. Stewart JE, Strack S, Graves P. Development of oral hygiene self-efficacy and outcome expectancy questionnaires. *Community Dent Oral Epidemiol* 1997; 25(5):337-42.

5. Cutler CW, Stanford TW, Abraham C, Cederberg RA, Boardman TJ, Ross C. Clinical benefits of oral irrigation for periodontitis are related to reduction of proinflammatory cytokine levels and plaque. *J Clin Periodontol* 2000;27(2):134-43.
6. Flemmig TF, Epp B, Funkenhauser Z, Newman MG, Kornman KS, Haubitz I, et al. Adjunctive supragingival irrigation with acetylsalicylic acid in periodontal supportive therapy. *J Clin Periodontol* 1995;22(6):427-33.
7. Barnes CM, Russell CM, Reinhardt RA, Payne JB, Lyle DM. Comparison of irrigation to floss as an adjunct to tooth brushing: effect on bleeding, gingivitis, and supragingival plaque. *J Clin Dent* 2005;16(3):71-7.
8. Al-Mubarak S, Ciancio S, Aljada A, Mohanty P, Ross C, Dandona P. Comparative evaluation of adjunctive oral irrigation in diabetics. *J Clin Periodontol* 2002; 29(4):295-300.
9. Sharma NC, Lyle DM, Qaqish JG, Galustians J, Schuller R. Effect of a dental water jet with orthodontic tip on plaque and bleeding in adolescent patients with fixed orthodontic appliances. *Am J Orthod Dentofacial Orthop* 2008;133(4):565-71.
10. Rosema NA, Hennequin-Hoenderdos NL, Berchier CE, Slot DE, Lyle DM, van der Weijden GA. The effect of different interdental cleaning devices on gingival bleeding. *J Int Acad Periodontol* 2011;13(1):2-10.
11. Chaves ES, Kornman KS, Manwell MA, Jones AA, Newbold DA, Wood RC.
12. Mechanism of irrigation effects on gingivitis. *J Periodontol* 1994;65(11):1016-21.
13. Deinzer R, Jahns S, Harnacke D. Establishment of a New Marginal Plaque Index With High Sensitivity for Changes in Oral Hygiene. *J Periodontol* 2014;85(12):1730-38
14. Benson BJ, Henyon G, Grossman E, Mankodi S, Sharma NC. Development and verification of the proximal/marginal plaque index. *J Clin Dent* 1993;4(1):14-20.
15. Berchier CE, Slot DE, Haps S, Van der Weijden GA. The efficacy of dental floss in addition to a toothbrush on plaque and parameters of gingival inflammation: a systematic review. *Int J Dent Hyg* 2008;6(4):265-79.
16. Hujoel PP, Cunha-Cruz J, Banting DW, Loeche WJ. Dental flossing and interproximal caries: a systematic review. *J Dent Res* 2006;85(4):298-305.
17. Hoover DR, Robinson HB. The comparative effectiveness of a pulsating oral irrigator as an adjunct in maintaining oral health. *J Periodontol* 1971;42(1):37-9.