

New Water Irrigator for Cleaning Dental Plaque

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Abstract

Patient with fixed appliances (braces) must have good oral hygiene to prevent dental caries, decalcification, periodontal problems and oral health diseases. Many orthodontic patients' complaint of not able to clean between their fixed appliances (braces) due to the arch wires prevented the insertion of the toothbrush. Food can also get stuck between the fixed appliances and their teeth. This could result in dental cavity and gum disease for this patient if left untreated. In this study, a new device of tooth cleaning was tested against normal tooth brushing. A new cleaning device which uses water irrigation to remove dental plaque on tooth enamel surfaces were develop for this study. Both method of tooth cleanings was compared between each other on the effectiveness to remove dental plaque on tooth enamel surfaces. In the end, water irrigator was found to be slightly more effective to clean dental plaque.

Keywords: Water irrigator; dental plaque; oral hygiene.

1. Introduction

Orthodontic patients usually presented with wires and brackets on their teeth which have more plaque retentive area compared to normal person (Beberhold et al, 2012). Therefore, they will have more difficulty in removing the dental plaque and require more effective ways to maintain the oral hygiene. A study suggested that orthodontic patients required extremely high standard of oral hygiene care to prevent oral diseases (Travess et al, 2004). If they failed to maintain good oral hygiene, oral diseases associated with plaque such as dental caries and periodontal diseases may develop either during treatment or after the removal of the orthodontics fixed appliances (Travess et al, 2004). Using manual toothbrush to remove dental plaque around the wire and brackets are difficult which require longer brushing times. Manual tooth brushing alone also is insufficient for orthodontics patient to sustain excellent oral hygiene. Many study have proved that tooth brushing alone will not remove all the dental plaque around tooth surfaces (Patricia et al, 2013). In a study whereby patient using Bass method technique to brush teeth have 24.8% of dental plaque, patient using Modified Stillman technique presented with 26.9% of dental plaque and patient with Scubbing technique have 24.5% of dental plaque (Patricia et al, 2013). This shows that, tooth brushing alone is not able to clean all the teeth surface perfectly.

Therefore, it has been recommended that orthodontic patients require adjunctive cleaning devices to aid in

oral hygiene care (Joshua M, 2010). Usually, as an adjunctive cleaning device patients need a tool that can easily and effectively remove dental plaque around brackets, wires and teeth. Apart from that, the tool must also be cost effective so that all patients could afford to have it at home. Some examples of adjunctive cleaning devices are floss, interdental brush and water cleaner device. There are several types of water cleaner device available in the market such as syringe type, electricity and battery operated (Sudhanshu K, 2015). However, the problem are the available water cleaner device are expensive and are not well available.

2. Methodology

2.1 Development of Water Irrigator

In this study, a prototype of water irrigator was designed and constructed. The water irrigator is faucet powered so that the pressure can be easily controlled by adjusting the tap. It is also a safety feature for the users to prevent any gum injury from excessive pressure of the water stream. The water irrigator is then attach to a long, narrow and angle tip. This feature is important in order to facilitate cleaning especially at the posterior region. It is also to ensure the safe distance between the tip and the tooth.



Figure 1. The prototype of the water irrigator

Apart from that, the pressure of the water irrigator was measured based on formula kilogram per square centimetre (kg/cm^2). The water stream was shot toward a measurement scale and reading was recorded. This step was repeated for several times and the mean was measured. Then, the stream area of the water irrigator was measured using the formula area of circle (πr^2). The pressure of the water stream was then calculated by divide the weight to the area of the water pressure before converted into *psi* unit. The pressure of the water irrigator stream was 74 *psi*. This is in the same range of other available water irrigators, which were between 10 *psi* to 90 *psi*.

2.2 Tooth Preparation

Four dental arches were prepared using sets of natural teeth mounted on plaster of Paris (PoP). Each set consist of 12 sound teeth from 6's to 6's (molar to molar). Then, followed by the placement of the orthodontic brackets on the buccal surface of every teeth on each set.

2.3 Artificial Plaque Preparation & Laboratory Test

Streptococcus mutans was grown on nutrient agar at pH 7 and incubated at 37°C under anaerobic condition (10% H₂, 10% CO₂, 80% N₂). The bacterial colony was then inoculated into 250mL of Brain Heart Infusion (BHI) Broth (Oxoid Ltd, Hampshire, UK) and incubated at 37°C for 24 hours. The turbidity of the bacteria culture was adjusted to 0.5 McFarland standard ($\approx 1.5 \times 10^8$ CFU/mL) with the use of spectrophotometer. Then, 15ml of 100% sucrose stock solution was added into 250mL of Brain Heart Infusion broth containing *S. mutans* (BHI-Sm). After that, approximately 20ml of stimulated saliva was collected and added into the mixture for each experiment from a single healthy volunteer to minimize any variations that may arise. The dental arches were placed inside the mixture. The biofilm reactor was used to run systems for two days in order the get sufficient thickness of the plaque.

After two days, the plaque was disclosed using disclosing gel and initial plaque score was taken. The presence of plaque was recorded based on Rustogi Modification of Navy Plaque Index (RMNPI). In RMNPI, the labial surface of each tooth was divided into 9 areas and then were score 1 if there is presence of plaque and 0 if there is absence of plaque at each area. Then, the total of the plaque score was sum up for each arch.



Figure 2. The plaque after been disclosed using disclosing gel

Each tooth in the dental arches was clean with water irrigator with the distance of 2cm for 15 seconds. The plaque score were recorded using RMNPI and then compared to the initial plaque score. The procedure was repeated using toothbrush which act as a control group.

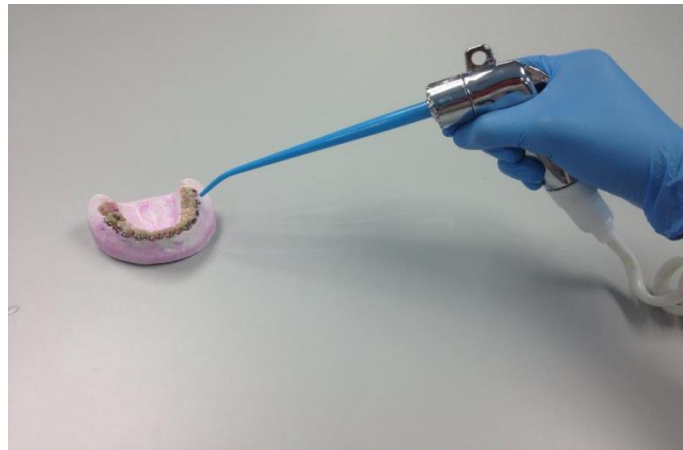


Figure 3. Water irrigator was used to remove the plaque.



Figure 4. Toothbrush (control group) was used to remove the plaque.

2.4. Statistical Analysis

Lastly, all the data were collected and analysed using SPSS version 22. Paired *t*-test was used to compare the mean of plaque score between before and after using water irrigator and toothbrush while Independent *t*-test was used to compare the difference in reduction of plaque score between water irrigator and tooth brushing.

3. Results

For the result, there are significantly 60% and 39% reduction of plaque score after using water irrigator and tooth brushing respectively with the *p*-value of 0.00. Based on the Table 1.0, it shows the mean plaque score before and after using water irrigator and tooth brushing. The water irrigator plaque score was 6.34 and after cleaning was 2.54. While toothbrush plaque score was 6.04 and after cleaning was 3.71.

	Before	After	p-value
Water irrigator	6.34	2.54	0.00
Toothbrush	6.04	3.71	0.00

Table 1.0: Mean plaque score before and after cleaning with two different methods.

Compared to the tooth brushing, water irrigator shows significantly better result in plaque removal. The mean plaque score are significantly different between water irrigator and tooth brushing with p value of 0.02. Based on Table 2.0, the reduction of the plaque score for water irrigator is 3.8 that is higher than tooth brushing which is 2.33. Thus, it proved that water irrigator has higher ability to remove plaque compared to tooth brushing.

	Water irrigator	Toothbrush	p-value
Plaque score reduction	3.8	2.33	0.02

Table 2.0: Comparison between mean reduction of plaque score between the two methods

4. Discussion

The first dental water cleaner device was invented in 1962 by John Mattingly and Dr Gerald Moyer in Colorado, United State of America. Since its development, the device has been studied in numerous research and clinical trial. A dental water irrigator is a device that delivers an irrigant such as water, mouthwash or an antibacterial rinse by a combination of pressure and pulsation (Macpherson P, 2012). It has been noted that pulsation has been shown to be more effective than a continuous stream (Gorur A et al, 2009). The dental water jet works by directly applying a pulsated stream of water at the dental plaque biofilm (Joshua M, 2010).

The efficacy of water irrigator is generally measured by supragingival plaque removal (Robinson PG et al, 2005). Based on a study, it has been shown that dental water irrigator can significantly remove both ex vivo and in vivo plaque biofilm (Gorur A et al, 2009). The usage of Water Flosser with normal toothbrush compared to dental floss with normal toothbrush is significantly more effective in removing dental plaque from enamel surface (Goyal CR et al, 2013). Besides its ability in removing plaque, water jet with additional of chlorhexidine gel could also help with the treatment of peri-implantitis lesions (Levin L et al, 2015). The dental water jet also able to prevent bleeding gum and gingivitis in various patient (Jahn CA, 2010). In a study the cleaning efficacy of sonic Waterpik toothbrush and 11 other types of toothbrush were tested in vitro on standard fixed appliance brackets on stained teeth which were covered with titanium oxide. The teeth were brushed with a machine for one minute each, before being scanned and assessed. The results shows sonic Waterpik toothbrush is significantly the third best-cleaner (Schatle M et al, 2010). Another study, compared the efficacy of plaque removal between waterpik water flosser with normal toothbrush and dental floss with normal toothbrush. The results show that waterpik water flosser is more effective (Goyal CR et al, 2013).

In another study, eight extracted teeth with advanced aggressive periodontitis were use in a study. Four of them were bath with saliva for four days before being cleaned with dental water irrigator. Another four

teeth with no additional salivary biofilm grown were straightly treated without dental water jet. The teeth were then evaluated with naked eyes and SEM. It been shows that dental water irrigator can significantly remove ex vivo plaque and also in vivo plaque biofilm (Gorur A et al, 2009). Another study look into the effect of a dental water jet towards supragingival biofilm under an electron microscope. It showed no deduction of biofilm nor irreversible damage to the biofilm matrix when compared to the untreated sites (Brady JM et al, 1973). Beside that, another study with teeth with periodontal problem treated with water irrigation shows randomly disseminated of short rods and few cocci with fibrin-like matrix. However, untreated teeth showed deposition of thick matted of organism (Cobb CM et al, 1988). A study showed that when an orthodontic jet tip was used with water jet on adolescents on fixed orthodontic appliances, dental plaque and bleeding score reduced (Sharma, 2011). In addition, the use of the water jet to toothbrush compared to toothbrush alone results in better reductions in gingivitis, plaque and gingival bleeding (Barnes, 2013).

This study has shown that the high potential of water irrigator to remove dental plaque in orthodontic patients. It can be used as an additional aid with tooth brushing to improve better oral hygiene. However, the limitation in this study is the established in vitro plaque may not be the same as intraoral plaque. Therefore, in future, the study should be tested in real patient and compare the effectiveness in plaque removal with other types of water irrigator.

5. Conclusion

In summary, the water irrigator and tooth brushing can be used to clean dental plaque accumulation on teeth with fixed appliances (braces). But when both of them compared in the effectiveness, water irrigator was significantly showed better results.

6. Acknowledgement

The researches would like to thank all of the staff in USIM and people who have contributed in this study directly or indirectly. Terima kasih.

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