Jurnal Sains Kesihatan Malaysia 21 (2) 2023: 47 - 59
DOI : http://dx.doi.org/10.17576/JSKM-2023-2102-05

Kertas Asli/*Original Articles*

Methods of Delivering Oral Hygiene Instructions Among Orthodontic Patients: The Past, Current and Future

(Cara Penyampaian Arahan Penjagaan Kebersihan Mulut Kepada Pesakit Ortodontik: Dahulu, Kini dan Akan Datang)

DEBORAH ANNE NATHAN DHANARAJU, NOOR SAM AHMAD,
NURUL ASYIKIN YAHYA & ASMA ALHUSNA ABANG ABDULLAH*

ABSTRACT

This review paper aims to present the evolution in methods of delivering oral hygiene information to orthodontic patients. Orthodontic fixed appliance treatment confers numerous benefits to patients in terms of occlusion, function and aesthetics, but it is associated with unwanted consequences due to challenges in maintaining oral hygiene. The ways of delivering oral hygiene information to patients have progressed over the years. Recent years have seen an increase in the popularity of incorporating technology in delivering oral hygiene information and monitoring of oral hygiene practices. The use of video-based instructions to web-based platforms such as Massive Open Online Course (MOOC) and social media platforms such as YouTube, Instagram and TikTok have all become a mode of oral hygiene information conveyance. Mobile apps are now a popular means to keep track of oral care practices such as toothbrushing frequency. The active ingredients of oral care products have improved providing a greater anticariogenic and antiplaque effect to the user as have the design of toothbrushes and even dental floss. In the future, more advanced technology may be used, such as artificial intelligence (AI) and machine learning, to create intelligent machines that can help educate patients on oral health maintenance and improvement.

Keywords: Oral hygiene; instructions; orthodontics

ABSTRAK

Kertas tinjauan ini bertujuan untuk membentangkan evolusi dalam cara penyampaian arahan penjagaan kebersihan mulut bagi pesakit ortodontik. Pendakap gigi ortodontik memberi banyak faedah kepada pesakit dari segi oklusi, fungsi dan estetik tetapi ia dikaitkan dengan masalah yang tidak diingini disebabkan cabaran dalam mengekalkan kebersihan mulut. Kaedah penyampaian arahan penjagaan kebersihan mulut kepada pesakit telah kerkembang sepanjang tahun. Sejak kebelakangan ini, didapati terdapat peningkatan dalam mengintegrasikan teknologi untuk menyampaikan maklumat kebersihan mulut dan memantau amalan penjagaan kebersihan mulut. Penggunaan arahan berasaskan video serta platform berasaskan web seperti 'Massive Open Online Course' (MOOC) dan platform media sosial seperti YouTube, Instagram dan TikTok telah menjadi mod penyampaian arahan penjagaan kebersihan mulut. Aplikasi mudah alih kini merupakan cara popular untuk memantau amalan penjagaan kebersihan mulut seperti kekerapan memberus gigi. Bahan aktif di dalam produk penjagaan mulut kini memberi kesan anti-plak dan anti-kariogenik yang lebih baik berbanding dahulu, begitu juga dengan rekabentuk berus gigi serta flos gigi. Pada masa hadapan, teknologi yang lebih maju mungkin digunakan, seperti kecerdasan buatan (AI) dan pembelajaran mesin, untuk mencipta mesin pintar yang boleh membantu mengajar pesakit tentang pemeliharaan dan penambahbaikan kesihatan mulut.

Kata kunci: Kebersihan mulut; arahan; ortodontik

INTRODUCTION

Orthodontic fixed appliances have been used to treat malocclusions and in recent years, both demand and accessibility for orthodontic treatment have increased. Orthodontic treatment is individualised for each patient to achieve the desired treatment objectives, and the basic components used are the brackets, bands, orthodontic wires and ligatures (Cerroni et al. 2018). With all these elements bonded intraorally, patients will have difficulty in maintaining adequate oral hygiene as a result of the predisposition for plaque accumulation on these appliances. Consequently, this results in the worsening of periodontal health (Contaldo et al. 2021; Gray et al. 2008) .

Regardless of the type of fixed appliance used, be it conventional, self-ligating or lingual brackets, there is an increase in oral microbiota amongst orthodontic patients perceivable even one month after bond up as the amount of dental plaque increases (Lucchese et al. 2018). This increase is not only a quantitative change but also a qualitative one with an increase in the amount of aerobic and anaerobic intraoral pathogens (Sun et al. 2018). Orthodontic appliances may inevitably cause a condition whereby it creates a conducive environment for the growth of anaerobic bacteria, shifting the profile from an aerobic predominance towards an anaerobic one which is pathognomonic with periodontal disease (Pan et al. 2017). This increase corresponds clinically to a worsening in the patient's Plaque Index and bleeding gums upon probing (Lucchese et al. 2018). Although orthodontic patients who were previously treated for periodontal disease showed better clinical parameters as compared to orthodontic patients with a healthy periodontium, their microbiological ecosystem reflects a statistically increased count of *Aggregatibacter actinomycetemcomitans* which is strongly associated with aggressive periodontitis when compared to periodontally healthy patients (Asma et al. 2020). Gingival enlargement as a result of poor oral hygiene has also been associated with a longer orthodontic treatment duration (Pinto et al. 2017). Thus, it is of utmost importance that effective oral hygiene be performed for shorter orthodontic treatment duration and to prevent a recurrence of the periodontal disease.

Yet another major sequelae of fixed orthodontic appliances is dental caries or demineralisation of enamel presenting initially as white spot lesions and this could be evident as early as one month after bond up and seen most frequently on the labiogingival surface of the upper lateral incisor (Khoroushi et al. 2017). This is because the orthodontic brackets and wires and other auxiliaries hinder proper cleansing. If brushing is not properly done, this would inevitably lead to plaque build-up (Moshkelgosha et al. 2017). Plaque build-up leads to gingivitis, nevertheless, this inflammation usually resolves not long after the appliance is debonded whereas white spot lesions pose a major aesthetic concern to patients (Verhoef et al. 2015). As most patients seeking orthodontic treatment do so for aesthetic purposes (Cai et al. 2018), unsightly white spot lesions post-debond would add to the burden of care as it would require additional treatment. These undue consequences may be prevented if proper oral hygiene is maintained throughout the treatment. Hence, orthodontic patients require thorough instructions of care and information regarding what they can expect to happen during their treatment.

In most orthodontic centres, patients are counselled about the importance of good oral health even before fitment of fixed appliances and indeed the appliances are not bonded up until the patient can routinely demonstrate a high standard of oral care (Lees and Rock 2000). Maintenance of good oral hygiene at home is entirely the responsibility of the patient as they would only visit their orthodontist once a month on average.

Plaque control can be achieved by mechanical or chemotherapeutic means with the most effective method being mechanical plaque control. Methods of mechanical plaque control are broadly classified as toothbrushing and interdental cleaning using aids such as interdental brushes and floss. Chemical plaque control is achieved by using antiplaque agents such as phenols, chlorhexidine and Delmopinol (Vyas et al. 2021).

With so much emphasis on the importance of good oral hygiene, it is not surprising that the means for mechanical cleansing have evolved over time. Toothbrushing has long been established to be paramount for plaque removal and reduces gingivitis (Pitchika et al. 2019). Oral health professionals recommend a minimum brushing time of two minutes. When the duration of brushing is increased, more plaque is proportionately removed (Vakil et al. 2019). An evolution to regular manual toothbrushes, powered toothbrushes that operate with a rotational and oscillatory motion have been shown to be more effective in promoting gingival health than manual toothbrushes during orthodontic treatment (Al Makhmari et al. 2017; Yaacob et al. 2014).

Regular toothbrushing alone would not suffice for orthodontic patients due to the presence of an orthodontic wire and brackets, hence other mechanical plaque removal agents such as interdental brushes and dental floss are advocated. The use of dental floss even amongst patients without orthodontic fixed appliances requires time and good manual dexterity and so only a small proportion of orthodontic patients would be expected to be able to demonstrate effective interproximal plaque control (Zanatta et al. 2011). More orthodontic patients use an interdental

brush compared to dental floss as flossing beneath the orthodontic wire is challenging (Lee et al. 2016). Water flossers are a relatively recent innovation that have been shown to be even more effective than regular floss in interdental cleansing and has been recommended for use by orthodontic patients (Abdellatif et al. 2021) .

In addition to mechanical means of oral care, chemotherapeutic agents such as dentifrices and mouthwashes complement plaque control measures by incorporating ingredients such as antiplaque agents, antimicrobial agents, antagonistic bacterial agents and topical fluoride to prevent dental caries and periodontal disease (Goyal et al. 2019; Hodge 2016). Another study found that probiotic mouthwashes are as effective as chlorhexidine and sodium fluoride mouthwashes in reducing salivary *S.mutans* counts without any toxicity while also improving periodontal health (Jothika et al. 2015).

The effectiveness of both mechanical and chemotherapeutic means of plaque control is dependent on the frequency and technique used while practising oral hygiene routines (Vakil et al. 2019). For orthodontic patients, the act of brushing itself induces mild pain which can be detrimental to oral hygiene efforts (Rakhshan et al. 2015). Therefore, it is prudent for the orthodontist to advise patients on what can be expected and how to properly care for their oral hygiene during the course of their treatment. Over the years, the methods employed to educate patients on how to care for their oral health while having fixed orthodontic treatment have also evolved. In the earlier years, verbal instructions which may have been supplemented with pamphlets were the most popular avenue available, however, with the advent of the internet and other recent technological advances, the medium of instructions used have also incorporated the use of electronic devices such as computers or tablets, smartphones, and wearable trackers.

This review paper will attempt to highlight the methods used for oral hygiene education over the years as well as the evolution of oral care products as shown in Figure 1.

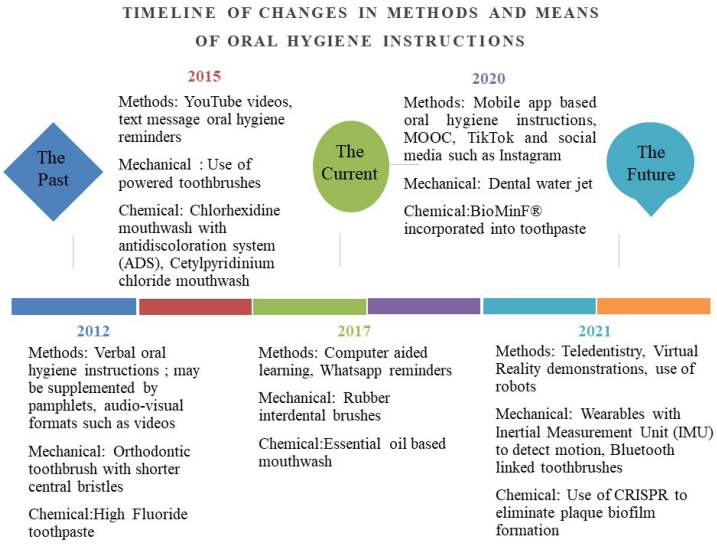

FIGURE 1. Timeline of changes in the methods and means of oral hygiene instructions

ORAL HYGIENE INSTRUCTIONS: THE PAST

Since the 1990s, dentistry has been moving toward a preventive strategy rather than a purely interventive one with greater emphasis on encouraging patients to adopt healthier oral health behaviours and habits (Amoo-Achampong et al. 2018). In the same manner, for orthodontic treatment to be successful, patients must be able to comprehend their treatment and their role in ensuring its success. Patients must be instructed well on how to brush their teeth while under orthodontic treatment and many factors play a part in deciding how best to communicate and provide this information to them.

Oral care instructions can be done in numerous ways. The simplest and most frequently employed method would be a verbal method and this has proven to be effective in improving gingival health (Kay et al. 2016). Oral hygiene instructions are usually conducted by a dental health professional giving verbal instructions to patients while demonstrating the techniques on teaching models. Dietary advice such as limiting the consumption of sugar to prevent dental caries is often included (Levin et al. 2015). These instructions could also be supplemented with pamphlets

(Azevedo et al. 2015) and an example of the clinical scenario can be seen in Figure 2. Conveying oral hygiene instructions verbally enables a clinician to develop a rapport with their patients and thus motivate them to regularly practise proper oral care (Harnacke et al. 2012). The downside of this method is that it requires the use of chairside time which can otherwise be utilised to treat other patients, especially in busy orthodontic clinics (Ozlu et al. 2021).

FIGURE 2. Patient receiving verbal oral hygiene instructions supplemented by pamphlet and model demonstration

Pamphlets have been widely used in the past to disseminate information to their target population and are still a popular means of information conveyance today. Most are designed to be readable by the majority of the population using a question-and-answer format which does not provide an interactive experience for the reader. Therefore, although they may be repeatedly referred to, they may not result in lasting retention of information (Wong et al. 2019).

The recall of the information provided verbally is of great concern to orthodontists as it is prudent that patients understand what is told to them and successfully retain the information provided. Studies have shown that patients remember less than half of the information given to them verbally and this may increase when additional written or pictorial information is provided (Ahmad et al. 2020; Ahn et al. 2019; Ozlu et al. 2021) .

As different individuals have different learning preferences, oral health practitioners must accept that there is no one-size-fits-all approach when it comes to health education. Along with an increase in literacy rate, comes a demand for high quality educational material. Delivering information via an audio-visual format has significantly increased knowledge retention in new orthodontic patients compared to the conventional written and verbal method (Ali et al. 2020).

When creating videos to teach patients on how to care for their orthodontic fixed appliance, the video must include adequate useful information and be compelling to viewers. A study conducted in Nigeria showed that schoolchildren exposed to a videotape of oral care information starring popular local actors which uses their traditional language had better oral hygiene than the group given verbal oral hygiene instructions and the control group who were not given either verbal or video instructions (Olubunmi et al. 2013). The advantage of video-based instructions is that it can repeatedly be used once produced.

The video sharing social media platform YouTube features a diverse range of video content and has been used to spread knowledge and health information. Most of the videos available are targeted toward children and posted by media outlets rather than oral health care professionals (Alraqiq et al. 2021).Therefore, the quality of the information garnered especially regarding oral hygiene whilst having orthodontic fixed appliance treatment is subpar (Topsakal et al. 2021). Orthodontists using this platform to educate their patients should be aware of the content of the videos before advising their patients to refer to those videos as a reference to care for their fixed appliances.

A patient's adherence to their oral care regimen is the extent that their behaviour follows the recommended advice given by their orthodontist (Clough et al. 2011). As an orthodontic patient is only routinely reviewed monthly, the role of active reminders to maintain good oral hygiene at home cannot be downplayed. Research has been done in the medical field on the effectiveness of text message reminders being effective in aiding smoking cessation efforts (Scott-Sheldon et al. 2016) and this has been translated over to the dental field not only as appointment reminders but also as oral care reminders. In two randomised controlled trials that followed patients for three months, subjects who were assigned to receive text message reminders to brush their teeth had a statistically significant reduction in plaque when compared to the control group who were not given any reminders (Bowen et al. 2015; Kumar et al. 2018)

The foremost oral hygiene advice given to new orthodontic patients is to brush their teeth at least twice daily. Although the use of a regular toothbrush is recommended, there are specially designed orthodontic toothbrushes available with shorter central bristles which incorporate a bracket groove (Figure 3). A split-mouth randomised controlled trial found no significant difference in the plaque and gingival bleeding indices with the use of an orthodontic toothbrush versus a conventional toothbrush (Gomes et al. 2012).

It is not only the design of toothbrushes that has evolved greatly over the past 100 years. The incorporation of technology into toothbrushes has become increasingly popular and various types of powered toothbrushes are available. They are the oscillating rotary toothbrushes that

rotate back and forth, sonic toothbrushes with vibrating brush heads and also ultrasonic toothbrushes with working frequencies of up to 10 MHz (Digel et al. 2020).

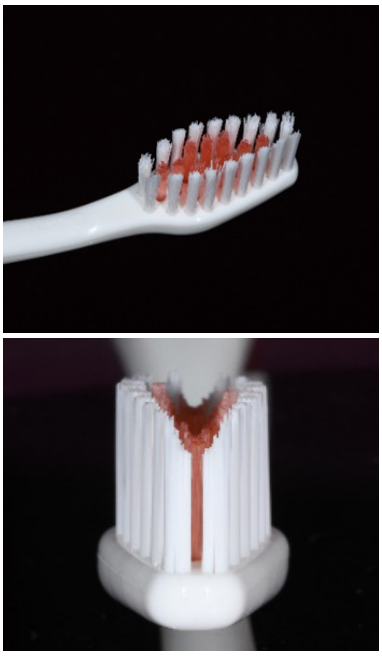

FIGURE 3. Orthodontic toothbrush head with a central trough

There are mixed results regarding the effectiveness of these powered toothbrushes as compared to manual toothbrushes. A long term study found that powered toothbrush users had better periodontal parameters compared to manual toothbrush users however, these results do not seem to apply to patients with existing severe periodontitis (Pitchika et al. 2019). In a systematic review, the use of a powered toothbrush was shown to be superior to a manual toothbrush in removing plaque in a one-off brushing exercise in healthy adult subjects (Elkerbout et al. 2020).

Sharma et al compared the effectiveness of manual orthodontic, powered and sonic toothbrushes on oral hygiene of fixed orthodontic patients. They found their effectiveness to be similar on plaque index, gingival index and interdental bleeding index although only the sonic toothbrush group consistently had a statistically significant reduction in gingival index scores at all intervals of the study (Sharma et al. 2015). Thus, if the technique of brushing is correct, any toothbrush is adequate for orthodontic patients to maintain their oral hygiene during treatment. Similarly, a cross-sectional study amongst university students who routinely used either a powered or manual toothbrush revealed similar distributions of plaque after a single brushing exercise and this also suggests the importance of brushing technique and knowing where to brush irrespective of toothbrush type (Petker et al. 2019). Any shortfalls of manual toothbrushing abilities cannot be overcome just by using a powered toothbrush alone.

The active ingredients in toothpaste have improved over the years. Fluoride has long been established as an effective means to prevent white spot lesions associated with orthodontic fixed appliance treatment (Bergstrand et al. 2011). Daily use of high fluoride toothpaste containing 5000ppm of fluoride was found to result in lesser white spot lesions during orthodontic treatment (Sonesson et al. 2014). Prevention of the formation of such lesions is a priority so that patients may have the best appearance possible post orthodontic treatment. Hence, this intervention is a worthwhile suggestion (Benson et al. 2019).

Chlorhexidine is a well-established effective antiplaque agent and is considered to be the 'gold standard' (Jones 1997). It is available as mouthwashes, sprays, gels and varnishes (Rajendiran et al. 2021). However, it is liable to cause brown pigment staining on teeth and prostheses with prolonged use. To combat this unwanted sequela, Anti Discoloration System (ADS) has been incorporated into chlorhexidine mouthwash. It was found that chlorhexidine mouthwash with ADS was effective as an antiplaque agent and resulted in lesser pigmentation (Marrelli et al. 2015).

The usage of chlorhexidine mouthwashes amongst orthodontic patients is effective in reducing the colonisation of bacteria around orthodontic brackets (Saffari et al. 2015). The amount of plaque and occurrence of gingivitis was found to be lower in the test group of orthodontic patients who used a 0.2% chlorhexidine mouthrinse as compared to the control group who used a fluoride mouthrinse (Gehlen et al. 2000).

Apart from incorporating chlorhexidine in mouthwashes, cetylpyridinium chloride (CPC) is another chemical agent that has been widely used. This quarternary ammonium compound is as effective as chlorhexidine at reducing dental plaque (Rahman et al. 2014). 0.05% CPC has been formulated along with 0.12% chlorhexidine and this combination was shown to have the same advantage as chlorhexidine, but with fewer adverse effects (Guerra et al. 2019).

ORAL HYGIENE INSTRUCTIONS: THE CURRENT

Nowadays, many utilise the internet and computer-aided learning (CAL) to share information on healthcare (Ab Malik et al. 2017).To develop adequate dental health education programs, oral healthcare providers must have a good grasp of how users obtain information on oral health via the Internet (Maharani et al. 2021).

A study done in Iran using computer-based methods to deliver oral hygiene and post bond up of fixed appliance instructions noted better oral hygiene as measured by Plaque Index and Bleeding on Probing Index amongst patients who received computer software that delivers oral hygiene instructions compared to those instructed verbally (Moshkelgosha et al. 2017).

The use of web-based platforms to promote oral health education in orthodontic patients has been tested for oral hygiene instruction conveyance. Massive Open Online Course (MOOC) is one type of online self-directed learning platform used by many universities in Malaysia to offer online courses. It has the advantage of remote learning and is accessible to anyone with internet access (Blum et al. 2020).

Thus, MOOC has been attempted by Malini et al. in 2021 to be used to disseminate oral health information to patients. It contained interactive information on the parts of orthodontic appliances as well as instructions on how to care for them. It also incorporated gamification elements to increase patients' interest. These patients needed about 30 minutes to complete the course (Malini et al. 2021). As MOOC is better viewed on computers or laptops to ease navigation, this somewhat limits its usability.

Mobile phones of today are no longer just devices to make and receive calls and messages. With the increasing affordability and necessity of mobile phones, most patients would own one. Based on the 2021 data obtained from Malaysian Communications and Multimedia Commission, 94.8% of the Malaysian population own a smartphone (The Malaysian Communications and Multimedia Commission 2021).

These devices can download mobile applications. Oral health professionals have now begun using these applications, or apps for short, as a means of education. Although a study has found that only 16% of app users frequently use a health app, they did find that younger people and women were among those found to be more likely to use a health app (Bach et al. 2020). The demographic profile of health-related app users do correlate with the profile of the profile of orthodontic patients, most of whom are younger and the majority are female.

FIGURE 4. Patient receiving mobile app-based oral hygiene instructions

Text message reminders can now be sent via smartphone messaging applications such as WhatsApp. WhatsApp has an added benefit over text messages in that they bypass carrier costs and short messaging service (SMS) roaming fees.

The 'Brush Game', an anonymous group chat created using WhatsApp by Zotti et al was intended to disseminate oral hygiene instruction among orthodontic patients. Tutorial videos on oral hygiene care during their orthodontic treatment were posted and subjects were able to download them onto their mobile phones. They were also required to submit selfies before and after using a plaque disclosing tablet weekly. While no difference between the two groups was noticed in the first 6 months of the trial, at 12 months, the intervention group had significantly lower values on plaque and gingival indices and also a lower incidence of new white spot lesions or caries than those in the control group (Zotti et al. 2016).

Another trial used a specifically designed mobile app to deliver oral hygiene instruction videos. An example of a patient using a mobile app on the dental chair is shown in Figure 4. The app could send push notifications to remind users to practise good oral hygiene three times daily. They found that at the end of their study both Plaque and Gingival Indices were statistically lower for the app-based intervention group compared to the control group given verbal oral hygiene instructions (Alkadhi et al. 2017).

The WhiteTeeth app developed in the Netherlands aimed to improve oral hygiene and increase the usage of fluoride mouthwash by incorporating behaviour changing techniques into the app (Scheerman et al. 2018; Scheerman et al. 2020). The contents of the app included information about the sequelae of poor oral hygiene including a screen for patients to upload a picture taken of their teeth after

using a plaque disclosing tablet whereby a patient can monitor their oral hygiene and thus implement an action to improve it, which is the end goal. The app can give direct feedback by providing positive reinforcement if a patient was able to demonstrate good oral hygiene by the absence of plaque in their selfie uploaded. If plaque was present, the app generates oral health advice and a video of a peer model which is a teenage patient showing how to clean their teeth while having braces.

Following this, the patient will be required to set a goal which includes changing the frequency or length of time spent brushing, using an interdental brush or a fluoridated mouthwash. The app will then prompt the patient to set a time to perform these tasks and a reminder may be set within the app. This serves to motivate the patients. Participants in the intervention group had a significantly higher reduction of plaque compared to the control group given routine oral care instructions at the 12-week follow-up (Scheerman et al. 2020).

A free toothbrush timer software called Brush DJ plays music from the user's smart phone to entice them to brush for the prescribed two minutes. This app is included in the British National Health Services (NHS) app library. A study assessing oral hygiene compliance utilised this app. The intervention group who used the app had a significant reduction in Plaque and Gingival indices compared to the control group given verbal oral hygiene instructions supplemented by brochures and videos. The authors postulated that apps may act as effective motivators and reminders to patients (Farhadifard et al. 2020).

The recent pandemic of COVID-19 has highlighted the importance of utilising all avenues to continue to provide care for our patients while reducing the amount of physical interaction. Social media platforms such as Instagram and Facebook are rife with medical and dental related content with users of these platforms in the thousands or millions. These platforms are accessible via smartphone apps as well which broadens their reach (Shafer et al. 2018). A study in Saudi Arabia found that Instagram was the preferred social media platform to receive oral health information amongst students (El Tantawi et al. 2019). Instagram has been found to be effective in disseminating oral health information amongst orthodontic patients thereby increasing their knowledge and improving dietary habits. This was done by Instagram posts of photos or short clips on oral health and dietary advice. However, it is inadequate to improve oral hygiene compliance as evidenced by bleeding, gingival and plaque scores which were similar to that of patients receiving regular oral hygiene instructions only (Scribante et al. 2021).

By 2019, TikTok which is a video-based mobile phone app favoured by the younger generation, had more downloads than Facebook and Instagram (Hayes et al. 2020). Videos related to oral hygiene and orthodontics can be found under the hashtags #oralhealth and #oralhealtheducation. Oral hygiene information provided via TikTok however is not adequately provided with elements such as brushing technique and interdental brush use not emphasized (Fraticelli et al. 2021). Thus, oral health professionals should harness the opportunity to utilise this medium to ensure that more comprehensive oral care advice is available to patients through this medium.

The tools for maintaining good oral health while undergoing fixed orthodontic treatment remain the same, however over time, improvements to the design of these tools have occurred. Interdental toothbrushes have been shown to reduce both dental plaque and gingival inflammation when used alongside regular toothbrushes. However, patients may find the metal wire in the middle of the brush to be uncomfortable (Ng et al. 2019). Rubber interdental brushes are a recent innovation which has shown similar efficacy in plaque control as conventional interdental toothbrushes. Moreover, patients find them more comfortable to use as they result in less gingival abrasion as well (Hennequin-Hoenderdos et al. 2018).

While manual toothbrushes and toothpaste are the most popular oral care tools, there are discussions on the usage of water floss and essential oils (Fraticelli et al. 2021). Water flossers are devices that spray water in pulses, and the water acts as traditional floss to clean in between teeth. The American Dental Association suggests water flossers for those who have difficulties in flossing (American Dental Association). The usage of a dental water jet does not result in significant oral hygiene improvements in patients undergoing fixed orthodontic treatment, however, the novelty of the device itself may motivate a patient to pay closer attention to their oral hygiene (Mazzoleni et al. 2019). Moreover, it is a good option for people who have difficulty with a flossing routine as it leads to a reduction of both plaque and gingivitis (Stauff et al. 2018).

Bioactive glass has a similar composition to bone and teeth and has been incorporated into toothpaste formulations in recent years. BioMinF® has shown good potential to promote remineralization potential (Imran et al. 2019). BioMinF® has an added advantage over traditional fluorides incorporated into toothpaste of sustained release of fluoride. It has been reported that salivary flow washes away traditional fluorides (Ali et al. 2020).

Mouthwashes contain chemicals such as chlorhexidine, fluoride, triclosan, cetylpyridinium chloride and recent interest has been for the use of more natural ingredients (Lee et al. 2021). Essential oil-based mouth rinses are commonly available for over-the-counter purchase. Studies have found that mouthwash containing 1% Matricaria chamomilla L. (MTC) to be as effective as Chlorhexidine

gluconate in controlling gingival inflammation among patients undergoing fixed orthodontic appliance treatment (Panagiotou et al. 2021). Listerine® is an essential oil-based mouthwash that has been found to result in a reduction of plaque and gingivitis when compared to control groups who did not use any mouthwash (Panagiotou et al. 2021). These mouthwashes are comparable to flossing to control interdental plaque and gingivitis (Alshehri 2018).

The usage of mouthwashes has been advocated to improve hygiene around the area of the orthodontic mini-screw. In this regard too, essential oils-based mouthwash is as effective as chlorhexidine mouthwash in reducing the microbiota present around the mini-screw (Abkulut 2019).

ORAL HYGIENE INSTRUCTIONS: THE FUTURE

The FDI World Dental Federation (FDI) had designed a framework for its Vision 2030 goals, which highlights the importance of accessibility of oral health delivery to all. Among the 3 pillars proposed in the Vision 2030 reports, the third pillar emphasises the need for the oral health professional to collaborate with other health workers to deliver sustainable, health-needs-based and people-centred healthcare. One recommendation is to use appropriate and ecologically friendly technologies to help patients (Glick et al. 2021). Thus, as evidenced by the current trends in healthcare whereby technological evolution is greatly influencing how healthcare is being monitored and given, it is prudent that the practice of dentistry evolves with the changing times. Few health technology evolutions will be discussed further.

Telehealth and teledentistry have gained traction since the onset of the COVID-19 pandemic (Abbas et al. 2020). Oral health promotion to an extent benefits from tailored oral hygiene instructions. The detection of dental caries via photographs followed by oral hygiene instructions based on those images is being trialled and compared to instructions given after a routine face-to-face dental examination (Estai et al. 2020). A previous trial has shown teledentistry to have a reasonable ability to detect caries (Estai et al. 2016). Future utilization of teledentistry during orthodontic treatment should be attempted to enhance easier accessibility of orthodontic care to patients, especially in remote areas.

Virtual Reality (VR) enables a more immersive experience to simulate a real world space (O'connor 2019). Currently, there is a study that uses a VR of a three-dimensional oral cavity to demonstrate biofilm formation and mechanical removal of the biofilm. Participants of this study demonstrated a higher frequency of toothbrushing after the VR exposure (Genaro et al. 2022). VR technology has more potential to be utilised and may benefit orthodontic patients, especially during oral hygiene demonstrations.

The term 'Dentronics' comprises the utilisation of artificial intelligence (AI) and machine learning (ML) along with robotics in dentistry (Grischke et al. 2020). AI refers to the idea of machines that can perform tasks normally done by humans while ML which is a subset of AI, refers to the employment of large amounts of data to learn patterns and structures in data, enhance knowledge , and thus able predictions of unseen data (Schwendicke et al. 2020). The idea of a dental training robot is not new. The incorporation of AI and 'Dentronics' in oral hygiene education has been attempted by a robot demonstrating tooth brushing techniques to patients. A study attempted to use a robot called ROBOTUTOR to teach patients brushing techniques. Subjects found this robot to be a more attractive method of oral hygiene information dissemination compared to a clinician or audio-visual method (Ahire et al. 2012). In the future, a robot with artificial intelligence may take over some of the work done by clinicians and customise orthodontic oral hygiene instruction to the needs of the patient.

Neural Networks are a type of ML that can recognise images and more complex data sequences. 'Deep learning' references deeper Neural Network architectures which classify images based on certain features and even textures (Choi et al. 2020). The identification of areas of dental plaque accumulation on teeth is important for reinforcing oral hygiene. These typically require manual detection or the use of special dyes and disclosing agents (Fasoulas et al. 2019). Neural networks can be trained to identify dental plaque based on photographs. Early research shows that these Artificial Intelligence models can detect dental plaque based on photographs with almost the same accuracy as a dentist (You et al. 2020). This could preclude the need for inconvenient usage of disclosing agents in the future.

Deep learning is utilised for activity recognition by smartphones and wearables such as the Apple Watch which have in-built capabilities to monitor aspects of health such as blood pressure and heart rate (Bhattacharya et al. 2016). Patients are now able to better understand their health status and keep track of their health in real-time with input from their physicians (Shetty et al. 2018). These wearables are embedded with an Inertial Measurement Unit (IMU) which can detect different motions and postures (Chen et al. 2021). Toothbrushes incorporated with a magnetometer can be used for brushing motion recognition using the inertial sensing data from a smartwatch.

Toothbrushing, as unremarkable as the act is, is often prone to recall bias, with patients not being able to recall the frequency or duration of brushing. With the advent of electronic or smart toothbrushes having the capability to

give feedback to smartphone apps, dentists would have the opportunity to accurately gauge a patient's oral hygiene practice while assessing oral hygiene outcomes in the clinic. A study developed a Remote Oral Behaviours Assessment System (ROBAS) on a regular electronic toothbrush that linked data via Bluetooth to a paired Android mobile phone. It collected data on patients brushing habits and the authors found that it was more reliable than daily diaries and provided a more objective and accurate representation of brushing behaviours (Shetty et al. 2020). Future innovations in toothbrushes and other associated brushing equipment will help to improve patients' oral hygiene.

Another exciting development that is still in its infancy is the utilization of CRISPR, or Clustered Regularly Interspaced Short Palindromic Repeats, to alter the genome of *S.mutans* by reducing their extracellular polysaccharide and biofilm formation. This in vitro study was able to eliminate dental plaque biofilm formation and thus prevent the occurrence of dental caries (Gong et al. 2018). A CRISPR-derived product that can help patients remove tooth plaque biologically may soon be available on the market.

CONCLUSION

As with other aspects of our daily life, technological advancements have greatly changed the modes of delivery of instructions, with a lesser reliance on written instructions alone. This also aids in reducing the chairside time which can potentially be used to treat other patients. In the future, communication between patients and their orthodontists will be more efficient with the help of the evolving technology of mobile phones and internet connectivity. The more widespread use of wearable technology should also integrate an oral care component to take advantage of its unobstructive nature and to pave the way for Dentistry 2.0 which is prevention rather than treatment driven, technology-enabled, and gives patients more control over their health.

REFERENCES

Ab Malik, N., Zhang, J., Lam, O.L., Jin, L. & Mcgrath, C. 2017. Effectiveness of computer- aided learning in oral health among patients and caregivers: A Systematic Review. *Journal of the American Medical Informatics Association* 24(1): 209-217.

Abbas, B., Wajahat, M., Saleem, Z., Imran, E., Sajjad, M. & Khurshid, Z. 2020. Role of Teledentistry in COVID-19 Pandemic: A Nationwide Comparative Analysis among Dental Professionals. *European Journal of Dentistry* 14(1): 116-122.

Abdellatif, H., Alnaeimi, N., Alruwais, H., Aldajan, R. & Hebbal, M. I. 2021. Comparison between water flosser and regular floss in the efficacy of plaque removal in patients after single use. *The Saudi Dental Journal* 33(5): 256-259.

Akbulut, Y. 2019. The effects of different antiseptic mouthwash on microbiota around orthodontic mini-screw. *Nigerian Journal of Clinical Practice* 2020(23): 1507-13.

Ahmad, N. S., Asma, A.A.A., Hafiz, A., Hamzah, N. & Mokhtar, N. 2020. Information retention in different methods of oral hygiene instruction delivery among orthodontic patients. *Indian Journal of Natural Sciences* 10(60): 0976-0997

Ahire, M., Dani, N. & Muttha, R. 2012. Dental health education through the brushing robotutor: A new learning experience. *Journal of Indian Society of Periodontology* 16(3): 417-420.

Ahn, J.H., Power, S., Thickett, E., Andiappan, M. & Newton, T. 2019. Information retention of orthodontic patients and parents: A randomized controlled trial. *American Journal of Orthodontics and Dentofacial Orthopedics* 156(2): 169-177.e162.

Al Makhmari, S.A., Kaklamanos, E.G. & Athanasiou, A.E. 2017. Short-Term and Long-Term Effectiveness of Powered Toothbrushes in Promoting Periodontal Health During Orthodontic Treatment: A systematic review and meta-analysis. *American Journal of Orthodontics and Dentofacial Orthopedics* 152(6): 753-766.e757.

Ali, U.M.M., Asma, A.A.A. & Yahya, N.A. 2020. Methods of Instruction on knowledge retention among orthodontic patients: A randomized controlled trial. *Malaysian Journal of Medicine and Health Sciences* 2020 16(3): 79-84

Ali, S., Farooq, I., Al-Thobity, A. M., Al-Khalifa, K. S., Alhooshani, K. & Sauro, S. 2020. An in-vitro evaluation of fluoride content and enamel remineralization potential of two toothpastes containing different bioactive glasses. *Bio-medical Materials and Engineering* 30(5-6): 487-496.

Alraqiq, H.M., Zhou, G., Gorglio, H. & Edelstein, B.L. 2021. Analysis of 100 most-viewed youtube toothbrushing videos. *Journal of dental hygiene* 95(5): 32-40.

Alshehri, F.A. 2018. The use of mouthwash containing essential oils (listerine®) to improve oral health: A Systematic Review. *The Saudi Dental Journal* 30(1): 2-6.

American Dental Association. 2023. Water flossers and water flossing. Mouth Healthy.

Amoo-Achampong, F., Vitunac, D.E., Deeley, K., Modesto, A. & Vieira, A.R. 2018. Complex patterns of response to oral hygiene instructions: Longitudinal evaluation of periodontal patients. *BMC Oral Health* 18(1): 72.

Asma AAA, Juhaida S, Badiah B, Zaleha S, Rohaya MAW.2020. Clinical and microbiological evaluation of stabilised periodontal patients undergoing early stage of orthodontic treatment. *Medicine & Health*. 15(2): 96-107

Azevedo, M.S., Romano, A.R., Correa, M B., Santos, I.D.S.D. & Cenci, M.S. 2015. Evaluation of a Feasible Educational Intervention in Preventing Early Childhood Caries *Brazilian Oral Research* 29(1-8).

Bach, R.L. & Wenz, A. 2020. Studying Health-Related Internet and Mobile Device Use Using Web Logs and Smartphone Records. *PLoS One* 15(6): e0234663

Benson, P.E., Parkin, N., Dyer, F., Millett, D.T. & Germain, P. 2019. Fluorides for Preventing Early Tooth Decay (Demineralised Lesions) During Fixed Brace Treatment. *The Cochrane Database of Systematic Reviews* 2019(11):

Bergstrand, F. & Twetman, S. 2011. A review on prevention and treatment of post-orthodontic white spot lesions - Evidence-Based Methods and Emerging Technologies. *The Open Dentistry Journal* 5 (2011): 158-62.

Bhattacharya, S. & Lane, N.D. 2016. From Smart to Deep: Robust activity recognition on smartwatches using deep learning. *2016 IEEE International Conference on Pervasive Computing and Communication Workshops (PerCom Workshops)*, hlm. 1-6.

Blum, E.R., Stenfors, T. & Palmgren, P.J. 2020. Benefits of Massive Open Online Course Participation: Deductive Thematic Analysis. *Journal of Medical Internet Research* 22(7): e17318.

Bowen, T.B., Rinchuse, D.J., Zullo, T. & Demaria, M.E. 2015. The influence of text messaging on oral hygiene effectiveness. *The Angle Orthodontist* 85(4): 543-548.

Cai, Y., Du, W., Lin, F., Ye, S. & Ye, Y. 2018. Agreement of young adults and orthodontists on dental aesthetics & influencing factors of self-perceived aesthetics. *BMC Oral Health* 18(1): 113.

Cerroni, S., Pasquantonio, G., Condò, R. & Cerroni, L. 2018. Orthodontic fixed appliance and periodontal status: An updated systematic review. *The Open Dentistry Journal* 12: 614-622.

Chen, C.H., Wang, C.C. & Chen, Y.Z. 2021. Intelligent brushing monitoring using a smart toothbrush with recurrent probabilistic neural network. *Sensors (Basel,Switzerland)* 21(4): 1238. 10

Choi, R.Y., Coyner, A.S., Kalpathy-Cramer, J., Chiang, M.F. & Campbell, J.P. 2020. introduction to machine learning, neural networks, and deep learning. *Translational Vision Science & Technology* 9(2): 14-14.

Clough, B.A. & Casey, L.M. 2011. Technological adjuncts to increase adherence to therapy: A review. *Clinical Psychology Review* 31(5): 697-710.

Contaldo, M., Lucchese, A., Lajolo, C., Rupe, C., Di Stasio, D., Romano, A., Petruzzi, M. & Serpico, R. 2021. The oral microbiota changes in orthodontic patients and effects on oral health: an overview. *Journal of Clinical Medicine* 10(4): 780

Digel, I., Kern, I., Geenen, E.M. & Akimbekov, N. 2020. Dental Plaque Removal by Ultrasonic Toothbrushes. *Dentistry Journal (Basel)* 8(1): 28

El Tantawi, M., Bakhurji, E., Al-Ansari, A., Alsubaie, A., Al Subaie, H.A. & Alali, A. 2019. Indicators of adolescents' preference to receive oral health information using social media. *Acta Odontologica Scandinavica* 77(3): 213-218.

Elkerbout, T.A., Slot, D.E., Rosema, N.A.M. & Van Der Weijden, G.A. 2020. How effective is a powered toothbrush as compared to a manual toothbrush? A Systematic Review and Meta-Analysis of Single Brushing Exercises. *International Journal of Dental Hygiene* 18(1): 17-26.

Estai, M., Bunt, S., Kanagasingam, Y., Kruger, E. & Tennant, M. 2016. Diagnostic accuracy of teledentistry in the detection of dental caries: A Systematic Review. *Journal of Evidence Based Dental Practice* 16(3): 161-172.

Estai, M., Kanagasingam, Y., Mehdizadeh, M., Vignarajan, J., Norman, R., Huang, B., Spallek, H., Irving, M., Arora, A., Kruger, E. & Tennant, M. 2020. Teledentistry as a novel pathway to improve dental health in school children: A research protocol for a randomised controlled trial. *BMC Oral Health* 20(1): 11.

Farhadifard, H., Soheilifar, S., Farhadian, M., Kokabi, H. & Bakhshaei, A. 2020. Orthodontic patients' oral hygiene compliance by utilizing a smartphone application (brush dj): A randomized clinical trial. *BDJ Open* 6(1): 24.

Fasoulas, A., Pavlidou, E., Petridis, D., Mantzorou, M., Seroglou, K. & Giaginis, C. 2019. Detection of dental plaque with disclosing agents in the context of preventive oral hygiene training programs. *Heliyon* 5(7): e02064.

Fraticelli, L., Smentek, C., Tardivo, D., Masson, J., Clément, C., Roy, S., Dussart, C., Bourgeois, D. & Carrouel, F. 2021. Characterizing the content related to oral health education on Tiktok. *International Journal of Environmental Research and Public Health* 18(24): 13260

Gehlen, I., Netuschil, L., Georg, T., Reich, E., Berg, R. & Katsaros, C. 2000. The influence of a 0.2% chlorhexidine mouthrinse on plaque regrowth in orthodontic patients. A randomized prospective study. Part II: Bacteriological Parameters. *Journal of Orofacial Orthopedics* 61(2): 138-148.

Genaro, L.E., Marconato, J.V., Hanai, D., Gobbo-Pawloski, C.L. & Capote, T.S.D.O. 2022. Virtual reality in oral hygiene instruction: An immersive approach *odovtos*. *International Journal of Dental Sciences*. 24(1):177-187.

Gomes, L. K., Sarmento, C. F., Seabra, F. R., Santos, P. B., & Pinheiro, F. H. 2012. Randomized clinical controlled trial on the effectiveness of conventional and orthodontic manual toothbrushes. *Brazilian Oral Research* 26(4): 360–365.

Gong, T., Tang, B., Zhou, X., Zeng, J., Lu, M., Guo, X., Peng, X., Lei, L., Gong, B. & Li, Y. 2018. Genome editing in streptococcus mutans through self-targeting crispr arrays. *molecular oral microbiology* 33(6): 440-449.

Goyal, N., Shamanna, P.U., Varughese, S.T., Abraham, R., Antony, B., Emmatty, R. & Paul, P. 2019. Effects of amine fluoride and probiotic mouthwash on levels of porphyromonas gingivalis in orthodontic patients: A Randomized Controlled Trial. *Journal of the Indian Society of Periodontology* 23(4): 339-344.

Gray, D. & Mcintyre, G. 2008. Does oral health promotion influence the oral hygiene and gingival health of patients undergoing fixed appliance orthodontic treatment? A systematic literature review. *Journal of Orthodontics* 35(4): 262-269.

Grischke, J., Johannsmeier, L., Eich, L., Griga, L. & Haddadin, S. 2020. Dentronics: Towards robotics and artificial intelligence in dentistry. *Dental Materials* 36(6): 765-778.

Guerra, F., Pasqualotto, D., Rinaldo, F., Mazur, M., Corridore, D., Nofroni, I., Ottolenghi, L. & Nardi, G.M. 2019. Therapeutic efficacy of chlorhexidine-based mouthwashes and its adverse events: Performance related evaluation of mouthwashes added with anti-discoloration system and cetylpyridinium chloride. *International journal of dental hygiene*17(3): 229-236.

Harnacke, D., Beldoch, M., Bohn, G.H., Seghaoui, O., Hegel, N. & Deinzer, R. 2012. Oral and written instruction of oral hygiene: A Randomized Trial. *Journal of Periodontology* 83(10): 1206-1212.

Hayes, C., Stott, K., Lamb, K. J. & Hurst, G.A. 2020. "Making Every Second Count": Utilizing Tiktok and systems thinking to facilitate scientific public engagement and contextualization of chemistry at home. *Journal of Chemical Education* 97(10): 3858-3866.

Hennequin-Hoenderdos, N.L., Van Der Sluijs, E., Van Der Weijden, G.A. & Slot, D.E. 2018. Efficacy of a rubber bristles interdental cleaner compared to an interdental brush on dental plaque, gingival bleeding and gingival abrasion: A randomized clinical trial. *International Journal of Dental Hygiene* 16(3): 380-388.

Hodge, P. 2016. Mouthwashes: Do they work and should we use them? Part 1: Antiplaque efficacy of mouthwashes. *Dental Update* 43(6): 536-544.

Imran, F., Abdul, M., Emad, A. & Khalid, A. 2019. Efficacy of a novel fluoride containing bioactive glass based dentifrice in remineralizing artificially induced demineralization in human enamel. *Fluoride* 52(3 Part 3): 447-455

Jones, C.G. 1997. Chlorhexidine: Is it still the gold standard? *Periodontology 2000* 15(55-62.

Jothika, M., Vanajassun, P.P. & Someshwar, B. 2015. Effectiveness of Probiotic, Chlorhexidine and Fluoride Mouthwash against Streptococcus Mutans - Randomized, Single-Blind, in Vivo Study. *Journal of International Society of Preventive & Community Dentistry* 5(Suppl 1): S44-48.

Kay, E., Vascott, D., Hocking, A., Nield, H., Dorr, C. & Barrett, H. 2016. A review of approaches for dental practice teams for promoting oral health. *Community Dentistry and Oral Epidemiology* 44(4): 313-330.

Khoroushi, M. & Kachuie, M. 2017. Prevention and treatment of white spot lesions in orthodontic patients. *Contemporary clinical dentistry* 8(1): 11-19.

Kumar, G.S., Kashyap, A., Raghav, S., Bhardwaj, R., Singh, A. & Guram, G. 2018. Role of text message reminder on oral hygiene maintenance of orthodontic patients. *Journal of Contemporary Dental Practice* 19(1): 98-101.

Lee, J. H., Asma, A.A.A., & Yahya, N.A. 2016. Oral hygiene practices among fixed orthodontic patients in a university dental setting. *International Journal of Oral and Dental Health* 2:027

Lee, S.H., Kim, W. H., Ju, K.W., Lee, M.S., Kim, H.S., Lee, J.H., Jung, Y.J. & Kim, B.J. 2021. Antibacterial and anti-inflammatory potential of mouthwash composition based on natural extracts. *Applied Sciences* 11(9):4227

Lees, A., Rock, W.P. 2000. A Comparison between written, verbal, and videotape oral hygiene instruction for patients with fixed appliances. *Journal of Orthodontics* 27(4): 323–328.

Levin, L., Bilder, L. & Borisov, O. 2015. Improving oral hygiene skills among children undergoing treatment at the Haemato-Oncology Department – An Interventional Programme. *International Dental Journal* 65(4): 211-215.

Lucchese, A., Bondemark, L., Marcolina, M. & Manuelli, M. 2018. Changes in Oral Microbiota Due to Orthodontic Appliances: A systematic review. *Journal of oral microbiology* 10(1): 1476645-1476645.

Maharani, D. A., El Tantawi, M., Yoseph, M. G. & Rahardjo, A. 2021. The use of internet platforms for oral health information and associated factors among adolescents from jakarta: a cross sectional study. *BMC Oral Health* 21(1): 22.

Malaysian Communications and Multimedia Commission, 2021. Full report Hand Phone Users Survey 2021

Malini, A., Asma, A.A.A., & Yahya, N.A. 2021. Online oral hygiene instructions for orthodontic patients in malaysian population. *Medicine & Health* 16(1):223-236.

Marrelli, M., Amantea, M. & Tatullo, M. 2015. A comparative, randomized, controlled study on clinical efficacy and dental staining reduction of a mouthwash containing chlorhexidine 0.20% and anti discoloration system (ads). *Annali di Stomatologia (Roma)* 6(2): 35-42.

Moshkelgosha, V., Mehrvarz, S., Saki, M. & Golkari, A. 2017. Computer-Based Oral Hygiene Instruction Versus Verbal Method in Fixed Orthodontic Patients. *Journal of dental biomaterials* 4(1): 353-360.

Mazzoleni, S., De Stefani, A., Bordin, C., Balasso, P., Bruno, G. & Gracco, A. 2019. Dental water jet efficacy in the plaque control of orthodontic patients wearing fixed appliance: A Randomized Controlled Trial. *Journal of Clinical and Experimental Dentistry* 11(11): e957-e963.

Ng, E. & Lim, L. P. 2019. An overview of different interdental cleaning aids and their effectiveness. *Dentistry Journal (Basel)* 7(2):56

O'connor, S. 2019. Virtual reality and avatars in health care. *Clinical Nursing Research* 28(5): 523-528.

Olubunmi, B. & Olushola, I. 2013. Effects of information dissemination using video of indigenous language on 11-12 years children's dental health. *Ethiopian Journal of Health Sciences* 23(3): 201-208.

Ozlu, F. C., Aktunc, E., Yilmaz, H. & Karadeniz, E.I. 2021. Effectiveness of three different types of educational methods on implementation of proper oral hygiene behaviour prior to orthodontic treatment. *Dental Press Journal of Orthodontics* 26(1): e2119248.

Pan, S., Liu, Y., Zhang, L., Li, S., Zhang, Y., Liu, J., Wang, C. & Xiao, S. 2017. Profiling of subgingival plaque biofilm microbiota in adolescents after completion of orthodontic therapy. *PLoS One* 12(2): e0171550.

Panagiotou, A., Rossouw, P.E., Michelogiannakis, D. & Javed, F. 2021. Role of essential oil-based mouthwashes in controlling gingivitis in patients undergoing fixed orthodontic treatment. A review of clinical trials. *International Journal of Environmental Research and Public Health* 18(20):10825

Petker, W., Weik, U., Margraf-Stiksrud, J. & Deinzer, R. 2019. Oral Cleanliness in Daily Users of Powered Vs. Manual Toothbrushes – A cross-sectional study. *BMC Oral Health* 19(1): 96.

Pinto, A.S., Alves, L. S., Zenkner, J., Zanatta, F. B. & Maltz, M. 2017. Gingival enlargement in orthodontic patients: Effect of Treatment Duration. *American Journal of Orthodontics and Dentofacial Orthopedics* 152(4): 477-482.

Pitchika, V., Pink, C., Völzke, H., Welk, A., Kocher, T. & Holtfreter, B. 2019. Long-term impact of powered toothbrush on oral health: 11-Year Cohort Study. *Journal of Clinical Periodontology* 46(7): 713-722.

Rahman, B., Alkawas, S., Al Zubaidi, E., Adel, O. & Hawas, N. 2014. Comparative antiplaque and antigingivitis effectiveness of tea tree oil mouthwash and a cetylpyridinium chloride mouthwash: A randomized controlled crossover study. *Contemporary clinical dentistry*. 5(4): 466-470.

Rajendiran, M., Trivedi, H.M., Chen, D., Gajendrareddy, P. & Chen, L. 2021. Recent development of active ingredients in mouthwashes and toothpastes for periodontal diseases. *Molecules* 26(7): 2001.

Rakhshan, H. & Rakhshan, V. 2015. Pain and discomfort perceived during the initial stage of active fixed orthodontic treatment. *Saudi Dental Journal*27(2): 81-87.

Schwendicke, F., Samek, W. & Krois, J. 2020. Artificial intelligence in dentistry: Chances and challenges. *Journal of Dental Research* 99(7): 769-774.

Saffari, F., Danesh Ardakani, M., Zandi, H., Heidarzadeh, H. & Moshafi, M. H. 2015. The effects of chlorhexidine and persica mouthwashes on colonisation of streptococcus mutans on fixed orthodontics o-rings. *Journal of Dentistry (Shiraz)* 16(1): 54-57.

Scott-Sheldon, L. A., Lantini, R., Jennings, E. G., Thind, H., Rosen, R. K., Salmoirago-Blotcher, E. & Bock, B. C. 2016. Text Messaging-Based Interventions for Smoking Cessation: A systematic review and meta-analysis. *JMIR Mhealth and Uhealth* 4(2): e49.

Scheerman, J.F.M., Van Empelen, P., Van Loveren, C. & Van Meijel, B. 2018. A mobile app (whiteteeth) to promote good oral health behavior among dutch adolescents with fixed orthodontic appliances: Intervention mapping approach. *JMIR Mhealth and Uhealth* 6(8): e163.

Scheerman, J.F.M., Van Meijel, B., Van Empelen, P., Verrips, G. H. W., Van Loveren, C., Twisk, J. W. R., Pakpour, A. H., Van Den Braak, M. C. T. & Kramer, G. J. C. 2020. The effect of using a mobile application ("whiteteeth") on improving oral hygiene: A Randomized Controlled Trial. *International Journal of Dental Hygiene* 18(1): 73-83.

Scribante, A., Gallo, S., Bertino, K., Meles, S., Gandini, P. & Sfondrini, M.F. 2021. The effect of chairside verbal instructions matched with instagram social media on oral hygiene of young orthodontic patients: A randomized clinical trial. *Applied Sciences* 11(2): 706.

Shafer, S., Johnson, M.B., Thomas, R.B., Johnson, P.T. & Fishman, E.K. 2018. Instagram as a vehicle for education: What radiology educators need to know. *Academic Radiology* 25(6): 819-822.

Sharma, R., Trehan, M., Sharma, S., Jharwal, V. & Rathore, N. 2015. Comparison of Effectiveness of Manual Orthodontic, Powered and Sonic Toothbrushes on Oral Hygiene of Fixed Orthodontic Patients. *International Journal of Clinical Pediatric Dentistry* 8(3): 181-189.

Sonesson, M., Twetman, S. & Bondemark, L. 2014. Effectiveness of High-Fluoride Toothpaste on Enamel Demineralization During Orthodontic Treatment—a Multicenter Randomized Controlled Trial. *European Journal of Orthodontics* 36(6): 678-682.

Stauff, I., Derman, S. H. M., Barbe, A.G., Hoefer, K.C., Bizhang, M., Zimmer, S. & Noack, M.J. 2018. Efficacy and acceptance of a high-velocity microdroplet device for interdental cleaning in gingivitis patients—A monitored, randomized controlled trial. *International Journal of Dental Hygiene* 16(2): e31-e37.

Sun, F., Ahmed, A., Wang, L., Dong, M. & Niu, W. 2018. Comparison of oral microbiota in orthodontic patients and healthy individuals. *Microbial Pathogenesis* 123(2018):473-477.

Topsakal, K. G., Duran, G.S., Görgülü, S. & Eser Misir, S. 2021. Is Youtube(Tm) an adequate source of oral hygiene education for orthodontic patients? *International Journal of Dental Hygiene* 20(3):504-511.

Vakil, N.S.S., Goyal, P. & Singh, A. 2019. Evaluation of relationship between time of manual tooth-brushing and plaque removal. *Saudi Journal of Oral and Dental Research* 4(5): 302-304

Verhoef, W.A., Livas, C., Delli, K. & Ren, Y. 2015. Assessing the standards of online oral hygiene instructions for patients with fixed orthodontic appliances. *Journal of the American Dental Association* 146(5): 310-317.

Vyas, T., Bhatt, G., Gaur, A., Sharma, C., Sharma, A. & Nagi, R. 2021. Chemical plaque control - A brief review. *Journal of Family Medicine and Primary Care* 10(4): 1562-1568.

Wong, S.T., Saddki, N. & Tin-Oo, M.M. 2019. Readability and suitability of oral health education pamphlets produced by the Ministry of Health Malaysia. *The Medical Journal of Malaysia* 74(4): 312-319.

Yaacob, M., Worthington, H.V., Deacon, S.A., Deery, C., Walmsley, A.D., Robinson, P.G. & Glenny, A. M. 2014. Powered versus manual toothbrushing for oral health. *The Cochrane Database of Systematic Reviews* 2014(6): Cd002281.

You, W., Hao, A., Li, S., Wang, Y. & Xia, B. 2020. Deep learning-based dental plaque detection on primary teeth: A Comparison with Clinical Assessments. *BMC Oral Health* 20(1): 141.

Zanatta, F. B., Moreira, C.H.C. & Rösing, C.K. 2011. Association between dental floss use and gingival conditions in orthodontic patients. *American Journal of Orthodontics and Dentofacial Orthopedics* 140(6): 812-821.

Zotti, F., Dalessandri, D., Salgarello, S., Piancino, M., Bonetti, S., Visconti, L. & Paganelli, C. 2016. Usefulness of an app in improving oral hygiene compliance in adolescent orthodontic patients. *The Angle Orthodontist* 86(1): 101-107.

Deborah Anne Nathan
Dhanaraju Noor Sam Ahmad
Nurul Asyikin Yahya
Department of Family Oral Health,
Faculty of Dentistry, Universiti Kebangsaan
Malaysia, Jalan Raja Muda Abdul Aziz
50300 Kuala Lumpur, MALAYSIA

Asma Alhusna Abang
Abdullah
Department of Pediatric Dentistry and Orthodontics,
Faculty of Dentistry, Universiti Sains Islam
Malaysia,
71800 Nilai, Negeri Sembilan, Malaysia

Correspondence: Asma Alhusna Abang Abdullah

Email address: asmaabdullah@usim.edu.my