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An Update on Oral Hygiene Products and Techniques

Abstract: The aim of this article is to update the reader on oral hygiene products and techniques. The evidence relating to the range of toothbrushing, interdental cleaning products and chemotherapeutic agents currently on the market will be discussed. It will be seen that choice of many of the oral hygiene products currently on the market is still largely a matter of personal preference.

Clinical Relevance: An inadequate oral hygiene regime may lead to caries and periodontal disease. It is important for clinicians to be able to recommend a preventive programme for dental and periodontal health that is supported by high quality, evidence-based clinical research.

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Oral health problems, such as caries and periodontal disease, may be associated with an inadequate oral hygiene regime. Patients often present with concerns owing to periodontal disease, caries, staining of their teeth and halitosis, that are consequences of poor oral hygiene. Poor oral hygiene may also pose a threat to general health in medically compromised individuals, such as diabetics or individuals who have an increased risk of bacterial endocarditis. Oral hygiene is the responsibility of both the patient and the dental professional and a sensible approach to the maintenance of good oral hygiene is a systematic preventive programme. Given the time restraints of everyday practice, oral hygiene advice needs to be effective and appropriate for the individual. For example, advice needs to be tailored for patients with implants or orthodontic appliances, reduced manual dexterity, or the medically compromised. The aim of this article is to provide an update of oral hygiene products and techniques that could be of benefit to our patients. We will restrict our discussion to products and techniques for home use, rather than the role of professional intervention.

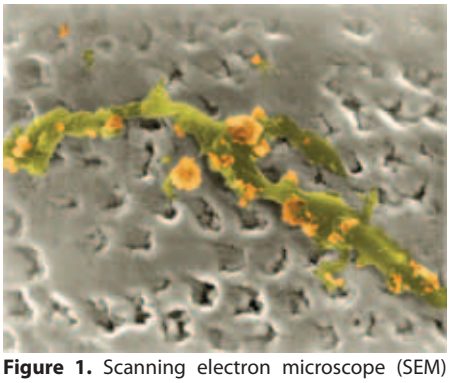

Figure 1. Scanning electron microscope (SEM) photograph of tooth surface with plaque deposit. Magnification x 435. © Dennis Kunkel Microscopy, Inc.

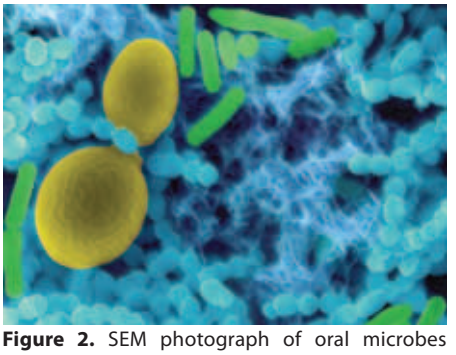

Figure 2. SEM photograph of oral microbes *Streptococcus mutans* (blue), *Porphyromonas gingivalis* (green), and *Candida albicans* (yellow). Magnification x 2000. © Dennis Kunkel Microscopy, Inc.

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What should an oral hygiene regime encompass?

The removal of plaque (Figure 1), a firmly adherent mass of bacteria (Figure 2) in a mucopolysaccharide matrix, from the tooth surface.

Plaque removal can be classified as either mechanical (toothbrushing, flossing and interdental brushing, prophylaxis) or chemotherapeutic (chemotherapeutic agents, such as triclosan, chlorhexidine). These are described below.

Figure 3. Oral B Triumph brush.

Figure 4. Oral B interdental brush attachment

Figure 5. Oral B orthodontic brush attachment.

Toothbrushing

Toothbrushing is a widespread healthcare practice. In the Adult Dental Health Survey of 1998,[1] 74% of adults claimed to clean their teeth at least twice a day, and yet many had received little or no instruction on how to brush their teeth effectively – 38% of dentate adults questioned in the above survey could not recall ever being given advice on toothbrushing or gum care.[1] The factors that may affect the efficacy of toothbrushing comprise the following:

- Type of toothbrush – manual versus powered;
- Frequency of toothbrushing and frequency of changing toothbrush;
- Technique of toothbrushing;
- Duration of toothbrushing.

This article will focus on the first three factors, in which there have been recent changes in both products and techniques.

Manual versus powered toothbrushes

The selection of a toothbrush is largely a matter of personal preference, affordability, and professional recommendation. Powered toothbrushes may have a particular appeal to some because they represent a newer 'high tech' solution to an everyday task. Introduced in the 1960s, early concerns for powered toothbrushes were their cost and potential for dental and gingival abrasion. However, their designs have subsequently been greatly modified, their prices reduced and many are equipped with pressure sensors that cut the power off if excessive pressure is used. In the UK, the volume of sales of powered toothbrushes has nearly doubled each year between 1999 and 2001, increasing from 2% of total sales of all toothbrushes in 1999 to 7% in 2001. As the powered toothbrush is so popular, the common question raised is which is better, the powered or manual?

Manual versus powered toothbrushes: the evidence

A recent Cochrane review compared manual and powered toothbrushes in relation to the removal of plaque, the health of the gingivae, staining and calculus, adverse effects and cost.[2] The meta-analysis involved 4-week randomized clinical trials comparing the efficacy of powered versus manual toothbrushes. Forty-two studies met the selection criteria, and involved 3855 participants over the review period of 1964 to 2004. It was found that brushes with a rotation-oscillation action (where brush heads rotate in one direction and then the other) removed plaque and reduced gingivitis more effectively than manual toothbrushes in the short term and reduced gingivitis scores in studies over 3 months. One such brush is the Oral B Professional Care Triumph brush (Figure 3). Oscillating-rotating brush heads specifically designed for interdental use with crowns, bridges and implants (Figure 4), and for use with fixed appliances (Figure 5), are available. The Philips Sonicare powered brush, a 'sonic' or high-frequency electric brush, found to be slightly inferior to the oscillating-rotating type,[2] is now available with a smaller brush head (Figure 6), designed to suit children, orthodontic patients and for precision brushing around implant fixtures. Powered brushes such as these have timers to indicate the duration of brushing, which may be particularly useful for children. In contrast to the findings of the Cochrane Review, a recent study by Sharma *et al.* (2006) evaluated the efficacy of plaque removal of an Oral B oscillating-rotating brush, the Philips Sonicare and a Waterpik power brush.[3] The latter is a toothbrush with a dual motor which produces approximately 40000 brush strokes per minute compared to, for example, a sonic brush which produces 31000 strokes per minute. In the randomized, single-blind prospective clinical trial by Sharma *et al,* with a sample of 144 subjects, they found that the Waterpik toothbrush compared favourably to the other brushes, with greater overall plaque removal.

Manual toothbrushes

For those who still prefer a manual brush, the available choice of brushes is seemingly endless. It is not presently possible to make a clear recommendation on toothbrush superiority as none of the trials in a recent Cochrane review compared the durability, reliability and cost of using specific toothbrushes. There is a clear need for long-term studies which evaluate the ability of newly designed brushes to reduce gingivitis and plaque. In particular, these studies need to be double-blind, randomized, controlled trials which are not subject to manufacturer bias. In the meantime, toothbrush choice remains a matter largely of personal preference.

Patients with fixed appliances are particularly susceptible to plaque retention and potential decalcification. They need to be prudent about their oral care and new products, such as the *Fresh & Go* all-in-one toothbrush and toothpaste (Figure 7), may be a convenient way of brushing whilst away from home. The

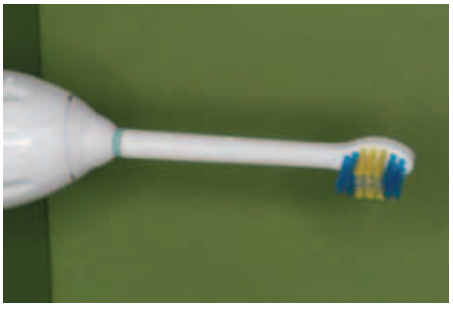

Figure 6. Philips Sonicare smaller head size.

Figure 7. *Fresh & Go* toothbrush and toothpaste.

Figure 8. *Fuzzy brush*.

'Fuzzy Brush' is an all-in-one toothbrush and breath freshener that gently cleans the teeth whilst it is chewed (Figure 8). It consists of a small, soft chewable brush presented in a small capsule. Although it has recently gained popularity, its use has yet to be supported by clinical evidence.

Frequency of toothbrushing and of changing toothbrush

Research indicates that the more often we clean our teeth, the better, because more frequent brushing will reduce plaque accumulation and gingivitis.[4] However, increasing the frequency of brushing does not automatically lead to cleaner teeth, as certain tooth surfaces, such as the proximal surfaces and the pits and fissures, are not optimally accessible to the toothbrush. Toothbrushing should therefore be supplemented by the use of floss and interdental brushes. Additionally, frequent, over-aggressive toothbrushing will promote gingival recession and may cause tooth abrasion. Axelsson (cited by Heintze *et al*,) suggested that all oral hygiene measures should be need-related.[5] Toothbrushing every other day would suffice for the avoidance of gingivitis, however, administration of fluoride two to three times daily is desirable to support remineralization. For that reason, the recommendation to brush after every meal remains justified, always assuming that the dentifrice contains fluoride.

There is inconclusive evidence about toothbrush wear and plaque removal.[6] Van Palenstein Helderman *et al* undertook a randomized cross-over clinical trial aiming to assess the plaque removal efficacy of new versus 14-month-old toothbrushes in 101 children aged between 7 and 8 years of age.[6] Using mean Quigley-Hein plaque scores before and after brushing with both types of toothbrushes, they concluded that the non-inferiority of old toothbrushes was validated. This conclusion, in contrast to what is generally thought and marketed by toothbrush manufacturers, is that the wear status of a toothbrush might be less critical for the maintenance of good plaque control. Their data is supported by other studies, in adults, which showed no difference at all in the plaque-removing efficacy of heavily worn toothbrushes as compared with that of toothbrushes with minor wear or no wear.[7,8]

Technique of toothbrushing

Several toothbrushing techniques have been proposed, such as vertical and horizontal scrubbing, the roll technique and the Bass technique. However, to ascertain which is the most appropriate it is worth considering the properties that an ideal technique would have:[9]

- Thorough cleaning of all the tooth surfaces, in particular the gingival crevice and the interdental area;
- No injury the hard or soft tissues, such as by abrasion or gingival recession;
- Be simple and easy to learn;
- Be systematic, so that all tooth surfaces are cleaned.

So, how many of the current techniques possess these properties? The scrubbing technique, both vertically and horizontally, cleans convex surfaces well but plaque is left in the interdental region. Additionally, scrubbing can cause dental abrasion and gingival recession, unlike the more gentle roll technique which does not. The roll technique involves placing the toothbrush against the side of the tooth with the bristles pointing apically, then gently sweeping the bristles downwards for maxillary teeth and up for the mandibular teeth. The shortcoming of this method is that it fails to clean the junction of the tooth with the gingival margin and the gingival crevice. The Bass technique superseded the roll technique owing to its superior cleaning of the gingival crevice. In this, the bristles of the toothbrush are held at about 45º to the long axis of the tooth, pointing towards the gingivae. The brush is pressed against the gingivae and moved with a small circular motion so that the bristles go into the crevice and between the teeth. This is currently the most effective method for the removal of plaque. Regardless of the technique used, it is the onus of the individual to ensure that brushing is undertaken systematically and that no areas of the dentition are overlooked.

Toothbrushing technique for orthodontic patients

A proper brushing technique for patients with fixed appliances means separate brushing of the tooth surfaces lying occlusal (Figure 9) and cervical (Figure 10) to the arch wire. Many patients place the brush too far coronally and neglect the gingival sections, leading to increased plaque formation and gingivitis (Figure 11).

Kremers *et al* found that, with a manual brush, a modified Bass technique (small, circular shaking motions, while the brush is held at a 45º angle to the tooth axis) was superior to the roll technique (rotating motions from the sulcus to the occlusal surface), because plaque removal was better on smooth surfaces.[10]

Patients with fixed appliances should apply more force than usual when using their brush. An increase in applied force from 0.6 to 5.0 N led to a 47% decrease in plaque deposition in patients with fixed appliances.[11] However, it was previously thought that brushing orthodontic fixed appliance brackets with a powered brush might be too aggressive,

Figure 9. Brushing occlusal to the arch wire.

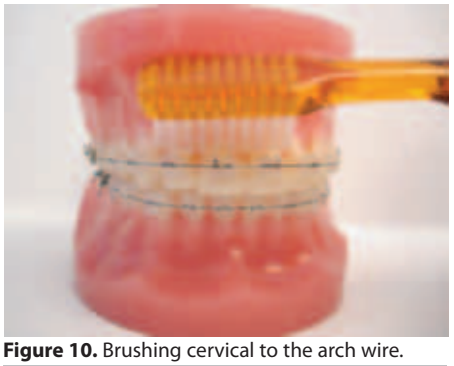

Figure 10. Brushing cervical to the arch wire.

Figure 11. Gingivitis below the lower incisor brackets.

Figure 12. *Reach Daily* flosser with snap-on heads.

with too much pressure, and cause debonding of the brackets. On the contrary, Gheewalla *et al* found, from a sample of 90 subjects, that three powered toothbrushes (Sonicare, Rota-dent®, and Oral B) did not have a deleterious effect on orthodontic bracket adhesion.[12] There is a need for long-term trials on the efficacy of powered brushes in orthodontic patients.

The use of disclosing solution

Disclosing solution is a solution that selectively stains all soft debris, pellicle and bacterial plaque on the teeth. Erythosin was the first dye to be used in dentistry for this purpose, preferentially on 1-2 day-old 'fresh' plaque. Other disclosing agents include malachite green, brilliant blue and fluorescein. The latter two disclose older (3 days or more) plaque better, which is beneficial as older plaque is more structured and contains more anaerobes, has more cariogenic and periodontopathogenic potential. In practice, however, the patient should be motivated to remove all plaque. Erythrosin is a suitable and inexpensive material for home use. Schafer *et al* investigated whether oral care feedback devices, such as disclosing tablets, would result in better plaque removal.[13] They found that the use of an adjunctive disclosing agent, compared to toothbrushing alone, led to significantly more plaque removal ($p < 0.05$) and brushing time was increased by 20%. They concluded that the use of disclosing agents could lead to increased plaque removal and increased motivation for toothbrushing.

Flossing and interdental brushes

The positive effect of dental flossing in the prevention of proximal caries and promotion of periodontal health is undisputed, however previous flossing trials in adults have shown significant study-to-study differences and a moderate to large potential for bias.[14] Studies have shown that gingivitis starts in the interdental space rather than lingually or buccally.[15] Optimal plaque removal is attained only when dental floss is used regularly and thoroughly at least every 2 or 3 days.[10] Brief episodes of flossing at shorter intervals has no effect.[16] A new section of dental floss should be used for each interdental space to avoid transfer of micro-organisms between sites.[17] Patients tend to avoid using floss as it is perceived to be time-consuming, uncomfortable, technically difficult, and the floss shreds between the teeth. Patient education is therefore the key to encouraging regular flossing. Various floss-holding devices, such as the *Reach Daily* flosser with snap-on heads (Figure 12) or the Oral B *Hummingbird*, are available and these may benefit patients who lack the dexterity for hand-held floss or who find flossing cumbersome.[18]

The use of interdental brushes confers additional benefits, in terms of plaque reduction, when they are used in conjunction with conventional manual brushes.[19] Interdental brushes have the advantage of also removing subgingival plaque, to a depth of 2.0 to 2.5 mm.[20] There are numerous types on the market, ranging in bristle hardness and handle design, however those with rounded bristles are advocated as they are less traumatic to the gingivae. Aside from their regular use in between the teeth, inderdental brushes are particularly useful for brushing around fixed appliance brackets, implants and bridge pontics and abutments. Further long-term studies are necessary to confirm their efficacy in the reduction of gingival bleeding or inflammation. Interspace brushes, also known as single-tufted brushes, are essentially small toothbrushes, and may be a useful adjunct for cleaning around fixed appliances (Figure 13) or furcation defects in a periodontally compromised patient.

Adjunctive chemotherapeutic agents

A number of chemotherapeutic agents to inhibit bacterial plaque formation, and thus prevent or resolve gingivitis, have been studied.[21] These agents can be divided into several groups, as shown in Table 1.

Of these agents, those in common use, such as chlorhexidine, listerine and triclosan, will be discussed.

Chlorhexidine

Chlorhexidine remains one of the most effective antimicrobial mouthwashes because it acts not only against gram-negative bacteria, but also against yeasts and gram-positive bacteria.[22] It is particularly suitable for the inhibition of plaque formation as it has the ability to maintain effective concentrations for prolonged periods of time, by way of binding to soft and hard tissues, a process known as substantivity.[23] However, with

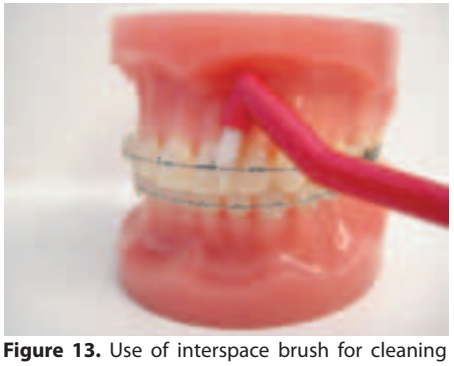

Figure 13. Use of interspace brush for cleaning fixed appliances.

Type of chemotherapeutic agent	Example
Enzymes	Proteases, Lipases, Dextranases
Bisdiguanides	Chlorhexidine
Quarternary ammonium compounds	Cetylpyridium chloride
Phenolic compounds	Listerine
Fluorides	Sodium Fluoride
Metal Ions	Copper, Tin
Oxygenating agents	Peroxide
Other antiseptics	Triclosan

Table 1. Chemotherapeutic agents for supragingival plaque control.[24]

long-term use, unpleasant side-effects, such as perturbance of taste, discoloration of teeth, composite restorations and orthodontic bracket adhesives occur. Other much more rare side-effects include mucosal erosion and parotid swelling.[24] It is therefore indicated for short-term use (up to 2 weeks) in patients with gingivitis and periodontitis, as well as before and after surgical procedures, such as removal of wisdom teeth.

Chlorhexidine is most commonly formulated as a mouthwash (*Corsodyl*, containing 0.2% chlorhexidine) but has also been incorporated into toothpastes and gels (*Corsodyl gel*, 1% chlorhexidine). However, chlorhexidine tends to bind to the components in toothpaste, decreasing the number of active cationic sites. As well as reducing the plaque inhibitory effects of toothpaste, the addition of chlorhexidine also stains the teeth. Hence, chlorhexidine toothpaste has not gained popularity. As a gel, the effects of chlorhexidine are prolonged, because the gel adheres to the tooth surface for a longer period. The gel can be applied with a toothbrush or to custom-made trays, the latter providing an even distribution of gel and fewer side-effects, such as pertubation of taste, because the gel is not distributed over the mucosal surfaces. Indications for use are for patients with gingivitis, peri-implantitis, and anti-cariogenic effects by causing a reduction in *Streptococcus mutans*. The tray therapy is inappropriate for young children, because they are likely to swallow much of the gel, and instead the gel should be applied with a toothbrush or a cotton roll.

Chlorhexidine solution in an oral irrigator, for example, the *Water-Pik*, can be particularly useful for patients with fixed appliances or with fixed bridgework, and is better than simple rinsing.[25] In a six-month study, the combination of a 0.06% solution (*Peridex*) and the *Water-Pik* was more effective in prevention of gingivitis than rinsing with a 0.12% solution or 'normal' oral hygiene or the *Water-Pik* with water only.[26] However, it needs to be made clear to the patient that irrigation can remove food debris but cannot remove plaque.

Triclosan

Triclosan is a non-ionic antiseptic that lacks the staining effects of cationic agents such as chlorhexidine. It has recently been used in a number of commercially available toothpastes and mouthwashes, and it produces moderate plaque inhibitory effects. Triclosan itself has little or no substantivity however, but there is evidence that its oral retention can be increased by its combination with co-polymers of methoxyethylene and maleic acid.[27] Deasy *et al* found from a clinical trial that the combination of 0.03% triclosan with maleic acid used as a pre-brushing rinse can produce significant adjunctive effects to mechanical oral hygiene in further reducing plaque levels and gingivitis.[27] However, the plaque inhibitory effects are much less effective than those of chlorhexidine. Gunsolley undertook a systematic review of the literature to evaluate the efficacy of anti-gingivitis and anti-plaque products in six-month trials.[28] His results supported the use of several agents as part of a typical home oral hygiene regime. In particular, 17 studies supported the anti-plaque and anti-gingivitis effects of toothpastes containing 0.3% triclosan and 2.0% maleic acid co-polymer. It had been previously thought that triclosan and zinc, agents with different modes of action, used in combination, might have synergistic or additive effects. However, the meta-analysis undertaken by Gunsolley found no evidence for the efficacy of triclosan products containing zinc.

Listerine

Listerine is an essential oil/phenolic mouthwash that has been shown to have moderate plaque inhibitory effects and some anti-gingivitis effects. The anti-inflammatory effects may be due to its antioxidative activity, however its lack of profound plaque inhibitory effect is probably because, unlike chlorhexidine, it has poor oral retention. Nevertheless, it has been accepted by the American Dental Association to be an aid to home oral hygiene measures. In comparison with chlorhexidine, chlorhexidine mouthwash was significantly more effective than *Listerine*, which was in turn slightly more effective than triclosan mouthwash in inhibiting plaque formation.[29]

Implications for practice

Toothbrushing

The choice of toothbrush is still a matter of personal preference. The evidence shows that worn toothbrushes are not inferior to new toothbrushes in the efficacy of plaque removal. There is no evidence that using a powered toothbrush will cause more dental and gingival abrasion than manual toothbrushing,[2] nor will it cause orthodontic brackets to debond.

Interdental cleaning

If a patient is having difficulty with conventional flossing, these alternatives may be of use:

- Wide floss;
- Dental tape;
- Floss holders to facilitate access to posterior teeth;
- Waxed floss as it tends to shred less and does not traumatize the papilla as much.

For example, *Glide floss* (manufactured by Crest) is made of Gore-Tex fibres (*Glide*) that are extremely thin and tear-resistant.[30] It should be borne in mind that the choice of interdental cleaning technique must be appropriate for the individual patient. For example, floss is suited to patients with small interdental spaces, and interdental brushes are more suitable to wider or open embrasures, such as in periodontal patients.

Chemotherapeutic agents

Chlorhexidine remains one of the most effective antimicrobial mouthwashes yet, owing to unpleasant associated side-effects, its use is not recommended longterm, and *Listerine* may be preferred. Triclosan and maleic acid formula toothpaste is an extremely efficacious product for plaque control.

Conclusions

This review has provided an update on current oral hygiene practice and advice that clinicians should be delivering to their patients. With a wide range of products currently available, it can be seen that there is a clear need for long-term clinical trials to substantiate their use. It is important for clinicians to be able to recommend products to their patients that are supported by high quality evidence-based clinical research.

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BookReview

Indirect Restorations. By David Bartlett and David Ricketts. New Malden: Quintessence Publishing Co. Ltd. (170pp. h/b, £28.00). ISBN 9781850970781.

In keeping with others in this series, *Indirect Restorations* is a well presented book, with a clear, well laid out text with many helpful and predominantly good quality and appropriate photographs. It covers fully the provision of crowns

I was a little puzzled that each chapter begins with Aims and Objectives – surely the same thing? Instead perhaps the chapters could have ended with a brief paragraph summarizing what one had just read and should have learnt.

The Introduction deals comprehensively with the causes of failure of indirect restorations – of the restoration itself and its supporting structures. It might have been worth mentioning the importance of incorporating plans for future failure in the initial treatment design.

The book includes, amongst others, chapters covering the indications for providing crowns; the use of different types of cores and their retention; the different types of posts; choosing the right type of crown and of the right material; their preparation; how to deal with short clinical crowns; the importance of paying careful attention to the occlusion and the use and place of articulators in the provision of crowns. Each chapter ends with a useful list of appropriate further reading material.

I was surprised, with the advances that have been made in luting cements, to find, in the chapter that included crown cementation, that cementation with zinc phosphate and polycarboxylate cements received more than just a passing historical aside.

The authors state that the book has not been written as a definitive work on the subject but as an overview of the key points with both general practitioners and students in mind – a balance that can be difficult to achieve. It is a useful guide and is a book that is easily readable by the dental team.

John Aitken
GDP, Kenilworth