International Journal of Enhanced Research in Medicines & Dental Care (IJERMDC),
ISSN: 2349-1590, Vol. 10 Issue 1, January 2023, Impact Factor: 7.125

Recent and Conventional Concepts of Mechanical Plaque Control Aids in Children–A Literature Review

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ABSTRACT

Plaquecan be defined as a specific but highly variable structural entity resulting from the colonization and growth of microorganisms on surfaces of teeth and consisting of numerous microbial species and strains embedded in an extracellular matrix. Plaque control is a pre-requisite in preserving a good dental, gingival and periodontal health. Dental plaque can be controlled either by mechanical, chemical methods or a combination of both. Currently, the different type of toothbrushes available are manual toothbrush, powered toothbrush, sonic toothbrush, ultrasonic toothbrush, Ionic toothbrush, laser toothbrush, disposable toothbrush, finger toothbrush, chewable toothbrush and musical toothbrushes.The customization of toothbrushes by modifying the size and form of the handle will permit sufficient grabbing in children with special health care needs. Routine use of mechanical plaque control aids should be incorporated into oral hygiene measures along with the newer advancements available. This article emphasizes on the mechanical plaque control aids used in children to maintain optimal level of oral hygiene.

Keywords: Plaque, Plaque Control, Mechanical Plaque Control, Toothbrush, Toothbrushing, Plaque Control in Children.

INTRODUCTION

Oral health is important for overall general health of an individual. Individual of all ages including young children suffer from dental diseases. Inspite of large possibility of contamination, oral cavity of a newborn is sterile at birth.[1]However, at or shortly after birth, colonization begins and within 24 hours, a newborn's body has to cope with the exposure to various bacteria.[2]The process of initial colonization begins with the inhabitation of pioneer microbial populations and newborn's oral cavity is usually enriched with the species of streptococcus. These colonizers act as niche and alter the already existing environment, and result in emergence of new populations.[3]

A phase of colonization between 19 to 33 months, begins with some cariogenic species such as S. mutans due to their preferable adhesion on tooth surfaces which was named as 'Window of Infectivity' by Caufield. The newly erupted primary molar represents a sterile environment which allows Mutans Streptococci to colonize the oral microflora, refraining engagement with otherpre-existing micro-organisms adhering to enamel surfaces. A second window of infectivity at 6 to 12 years with the eruption of first permanent molar has also been proposed.[4]As microbes colonize on the tooth surface, they form a **biofilm**. Before a biofilm forms, a layer of soft accumulations of bacteria and tissue cells occurs which lacks the organized structure of dental plaque which is known as Materia Alba. This soft accumulation can be easily displaced by water spray.[3] According to WHO, **Plaque** is defined as a specific but highly variable structural entity resulting from the colonization and growth ofmicroorganisms on surfaces of teeth and consisting of numerous microbial species and strains embedded in an extracellular matrix.[5] Dental plaque forms after 1-2 days if no oral hygiene maintenance has been there. The formation of dental plaque is divided into several stages namely, Pellicle formation on tooth surface**,** Initial attachment of bacteria and Colonization and maturation of plaque. All the surfaces of oral cavity are lined by a layer of organic material which is known as *Acquired Pellicle.* This pellicle is thought to form within 1 minute on a clean enamel surface. It consists of two layers: a thin basal layer which is difficult to remove and thicker globular layer which is easier to remove. Bacteria adheres to the tooth surface with the help of pellicle which is an active adhesion process. [6]On a primary tooth, de novo plaque is formed to a smaller extent due to different gingival conditions than on a permanent tooth surface.[7]

The predisposing factors such as compromised oral hygiene,partially exfoliated, loose primary teeth, malposed teeth, high frenum attachment and carious teeth causing food lodgement contribute to plaque accumulation.To overcome these predisposing factors, certain routine oral hygiene practices arerequired to maintain optimal oral health. This is achieved with the help of brushing andother plaque control aids along with examination of plaque professionally.[8]

The present review enlightens about various conventional and recent advancements in mechanical plaque control aids usedin reducing microbial load in children.

Mechanical Plaque Control In Children

Variouslandmark studies have been enlisted in Table1 highlighting the efficacy of various mechanical plaque control aids used in children.

Table 1 .Various landmark studies on mechanical plaque control in children

Year	Authors	Study on	Findings
1986	Bastiaan et al[9]	To compare plaque removing effects of a double headed toothbrush and a single headed flat toothbrush in 34 boys aged 11-13 years.	Double-headed brushes cleaned better on a lingual surface than a standard single-headed brush.
2001	Costa et al[10]	Effectiveness of plaque control performed with electric and manual toothbrushes on 15 children with primary dentition and 14 children with mixed dentition.	It was concluded that electric toothbrushes significantly reduced plaque on the lingual surfaces of teeth than the manual toothbrush.
2013	Muller et al[11]	To identify the effectiveness of tooth brushing methods in removing plaque.	It was observed that brushing quality was more important in late mixed dentition periods and horizontal scrub was better for younger children.
2018	Murthy et al[1]	To compare the effectiveness of plaque control with Novel Pedaitric Oral Hygiene Need Station (modified oral irrigation device) with manual brushing and flossing in children.	The authors stated that novel pediatric oral hygiene need Station is more effective than manual brushing in children as it combined the effect of brushing, flossing, and rinsing simultaneously.
2019	Kayalvizhi et al[12]	To compare the plaque removal effectiveness of a chewable Brush with manual toothbrush.	It was concluded that Chewable Brush reduced plaque, particularly on the lingual surfaces, thereby improving oral hygiene and gingival health status.
2020	Lin et al[13]	To compare the effectiveness of Gumchucks flossing system with string floss for interdental plaque removal.	It was stated that Gum Chucks was an effective interdental plaque removal aid that allows children to floss with greater speed and efficacy.
2021	Davidovich et al[14]	To evaluate the plaque	It was found that an

		removal efficacy of an electric toothbrush in primary and mixed dentition.	electric toothbrush reduced significantly more plaque than a manual toothbrush in both the pediatric age groups.
2021	Melo et al[15]	To evaluate the effects of day & night brushing programme on oral health knowledge and behaviour in children.	The results of the study showed that Brushing Day and Night programme was effective in improving children's well being and reducing plaque as compared with control population.

Various mechanical methods of reducing plaque include use of toothbrush, floss and interdental brushes.Tooth brushes are most widely used mechanical plaque control aid in children.[16]Currently,the different type of toothbrushes available are manual toothbrush, powered toothbrush, sonic toothbrush, ultrasonic toothbrush, Ionic toothbrush, laser toothbrush, disposable toothbrush and smart toothbrush.[17] Toothbrushes that are designed for children include– Musical toothbrush, Chewable toothbrush, Triple headed toothbrush and Finger brush.[18]

Toothbrushes

Manual toothbrushes are most common means of maintaining excellent oral hygiene, when compared with other oral hygiene aids due to their widespread accessibility and are also simple to use. It has proven to bethe most effective aid in elimination of dental plaque in children, although theirpotential to adequately use the toothbrush significantly depends on their age, manual dexterityand motivation.[12]The American Dental Association (ADA) has established guidelines for an effective toothbrush surface. (Table 2)

Table 2 - ADA specifications for brushing surface

Length	1 to 1.25 inches
Width	5/16 to 3/8 inches
Surface area	2.54 to 3.2 sq.cm
No. of rows	2 to 4 rows of bristles
No. of tufts	5 to 12 per row
No. of bristles	80 to 85 per tuft

Different sizes of heads are available varies according to the size of the oral cavity and individual's age.[18] (Table 3)

Table 3 - Sizes of toothbrush head according to age

Age	Brush head diameter
0-2 years	15 mm
2-6 years	19mm
6-12 years	22 mm
Above 12 years	25 mm

Powered toothbrushes were discovered in 1960s, as a replacement to the manual way of tooth cleaning. These operate via oscillatory, rotatory, or vibratory movements and requires negligible motion of hands.[19]Brush heads on powered toothbrushes are often smaller than those on manual toothbrushes. Bristles are also organised in more closely packed single tufts, allowing for easier interproximal cleaning and brushing in areas of the oral cavity that are less accessible.[17]The bristle bundles are mounted in a spherical head, either in rows.Various studies have found that powered toothbrush is more effective in plaque elimination than a manual toothbrush in children with age ranging from 3 to 13 years.[19,20]

An **Ultrasonic toothbrush** is a manual brush having a piezoelectric ultrasonic emitter integrated in its brush head. A 1.6 MHz power supply in the handle powers the ultrasonic emitter. The plaque controlling ability of ultrasonic emitter and deep, gentle cleansing wave action of sonic vibration penetrates the gingival sulcusup to 5 mm depth. It helps in removal of stains of coffee, wine, nicotine and food, works under braces and also proves to be very gentle for use in children.[17]

Ionic toothbrushes operate on the principle ofpolarity which means that everyatom of this universe is either positively or negatively charged. These tooth brushes remove plaque mechanically like manual toothbrushes too and by their specific ionic dynamics on the surface of the tooth.[21]

In a study by *Shin et al*[22] in patient between 3 to 6 years of age to compare effectiveness of sonic and manual toothbrushes, it was found that sonic toothbrushes are more effective in reducing plaque as compared to manual toothbrushes.

Chewable toothbrushes are a small plastic moulds which can be utilised when there is no water available. These toothbrushes are quite small, and shouldn't be swallowed and thrown away after use. These are made up of xylitol, flavouring aqua, and polydextrose.[12, 17] A study compared chewable brush with manual toothbrush in children and found more reduction in plaque with chewable brush, mainly on the lingual surfaces. The reason for increased efficiency was novelty of chewable toothbrush as it was designed to be chewed like a chewing gum.[12]

Finger brushes can be worn on the fingers by parents/gaurdian. These tufts are composed of silicone rubber and are arranged in rows.These allow for enhancedmanual dexterity, as pressure is simple to modulate and improvedtactile sensitivity. Due to its structural nature, it easily reaches all surfaces of the mouth and protects the digit from the biting forces.[12, 23] In a study by *Kumar et al*[23]on efficacy of finger toothbrushes in plaque control in children of 3 to 6 years of age, it was found that finger toothbrushes were equally efficacious in plaque removal as manual toothbrushes.

Musical Toothbrush was introduced in order to make toothbrushing habit more interesting to children. In this, light and the music starts to play, moment the child begins brushing upto 2 minutes of duration, after which light and music ends automatically. The main aim of this approach is to incorporate a 2-min toothbrushing habit among them.The benefits of music among children include a sense of pleasant mood, attentiveness, and learning habits. Moreover, the effect of light provides a visual environment that motivates them and alters their mental attitude and performance skills.[24]

An effective strategy to eliminate plaque from the teeth is by addition of a suitablemethod for tooth brushing along witha proper**toothbrush grip**. *Five types of distinct grips* are used namely, distal oblique, oblique, power, precision, and spoon. The palm of the hand is used in power and distal oblique grips, while the fingers are used in other three grips.[25,26] Plaque removal efficacy has been found to be higher when distal oblique grip is used by children.[27]

The most commonly stated factors for toothbrushing success include, design of toothbrush, brushing time, parental engagement, brushing technique, manipulative skill, andchild's hand dexterity.[28] Before 1950s, several**brushing techniques**were suggested by many clinicians, some of which are discussed below:

In Horizontal Scrub Technique, the bristles are angled at 90 degrees to the tooth's long axis and brush is moved horizontally in a light scrubbing motion. It is recommended for preschool children.[11,29]In a systematic review by *Muller-Bolla et al* [11], it wassuggested that horizontal scrub technique is considered best in children upto 6 years of age as other techniques of toothbrushing are difficult to apply, considering the development of motor skills at that age. In Fones Technique (Circular Technique), child occludes his/her teeth and toothbrush bristles are placed perpendicular to the tooth. Plaque removal is done using fast, wide and circular motion of toothbrush extending from marginal gingiva of maxilla to the marginal gingiva of mandible using moderate pressure 4-5 times, repeating for every group of teeth. It is indicated for young children.[28] In Modified Bass Method/Sulcus Cleaning Method, brush head is equidistant to theplane of occlusion and it coversnearly 3 to 4 teeth beginning from themost posteriorteeth. The bristles are arranged at angle of 45 degrees to the tooth's long axis near gingival crevice.[29]Short side to side movements are used to apply light vibratory pressure, dislodging the bristle tips.It is recommended for individuals with 13-17 years of age.[28] It is often one of the most favourablemethod of brushing, with research indicating that via intrasulcular cleaning, it causes plaque elimination and improves gingival health.[29]

Dentifrices

Dentifrices aid in cleaning and polishing the surface of teeth and their use with toothbrush is the commonly used mode of oral hygiene maintenance**.**[30]They can be made into powders, gels, or toothpastes depending on the water content.[31] They also comprise of humectants like glycerol, xylitol, and sorbitol, flavouring and colouring agents. They also have anti-plaque and anti-calculus characteristics, because of the presence of agents like pyrophosphates.[30,32]

A child's dentifrice is low in abrasiveness and as they generally tend to use larger amounts of toothpaste, brush for a longer period of time, rinse and expectorate less.[32]So,AAPD recommends the use of 0.5% fluoride containing toothpaste for children under the age of six.[33]

Amount of dentifrice used:

- Using no more than a smear or rice-size amount of fluoridated toothpaste for children less than three years of age may decrease risk of fluorosis.
- Using no more than a pea-size amount of fluoridated toothpaste is appropriate for children aged three to six.[34]
- After 6 years of age, half load of fluoridated toothpaste is mostly used. [35]

Interdental aids

In the 1960s, interdental brushes were originated as a replacementto wooden sticks. They come in a variety of sizes and shapes. Cylindrical or conical/tapered (like a Christmas tree) morphologies are the most prevalent. These are currently available in sizes ranging from 1.9 to 14 mm in diameter to fit the tiniest to the largest interdental spaces. The brush need to be carefully placedin middle of two teeth and not to force into the gaps while in use.These are usually recommended for children undergoing orthodontic treatment.[36]

Dental floss is one of the popular modeof maintaining the interdental hygiene. When used in conjunction with toothbrushing, it has a considerable impact on elimination of plaque and improved gingival health of an individual. Flossing is important for prevention of tooth decay in children less than 3 years of age and need to be started when primary teeth establish contacts proximally. The prevalence of proximal caries and gingivitis grows dramatically during this time, yet successful flossing requires manual skill and instruction, which is not anticipated of children under the age of 8.[13]

A survey conducted on the usage of floss among elementary school children and their guardians reported that the usage of dental floss by guardian's had a positive relation with the usage of dental floss among children.[37] Few authors suggested that flossing along with other interdental aids prove to be effective in reduction of interdental plaque in children.[1,13]

Chewing Stick

Chewing Stick is a traditional toothbrush is strongly ingrained in Asian culture because of its strong religious and spiritual significance. On one end, pencil-sized twigs of different plants are chewed tillthey shred into a brush. Chewing sticks or miswak are the common names for them when used in this way. [38]

Plaque Control Considerations In Special Child

Physical, cognitive, and behavioural impairments may make mechanical and chemical plaque management treatments problematic for people with severe disabilities including children. As a result, changes to standard preventive measures are required. There are a variety of toothbrush designs, dentifrices, and antibacterial agents available.[36]

Dentifrices should also be explored in severely impaired people. Toothpaste foaming and excessive salivation generated by tooth brushing can result in restricted visualisation of areas to be cleaned, acute choking, and toothpaste ingestion. It has been suggested that non-foaming toothpaste, such as NASADENT as used by astronauts, is regarded safe for consumption and has a pleasing taste. Individuals with severe disabilities may find the traditional process of washing and expectorating challenging, hence other approaches like sprays or swabs have been adviced.[36]

The customization of toothbrushes by modifying the size and form of the handle will permit sufficient grabbing in children with poor motor coordination, grip issues, or excessive spasticity. [32, 39]

Some of the modifications that can be done are:

• Attaching the brush to the person's hand using wide elastic bands or Velcro fasteners.
• For individuals with limited grasp, the brush handle can be enlarged using a sponge, rubber ball or a bicycle handle grip.
• For individuals who are unable to raise their hand or arm, the length of the brush can be increased with ruler, tongue depressor or long wooden spoon.[39]

A study conducted by *Raiyani et al*[40]reported that plaque removal efficacy in visually impaired children between 3 – 12 years was higher when distal oblique grip was used. A systematic review on utilization of toothbrushes with special grip on oral hygiene in cerebral palsy patients reported that the toothbrush with special handle helps maintain the oral hygiene in children.

CONCLUSION

Number of bacteria in the dental plaque can cause variety of diseases including caries and gingival disease. It is very necessary to disrupt the plaque in order to maintain oral cavity free of dental diseases. Amongst the various

plaque control aids, mechanical, chemical and biological are widely used in children. Mechanical plaque control, along with chemical and biological plaque control, offers great potential in maintaining oral hygiene in children.[30] Mechanical plaque control aids for children include toothbrushes, interdental aids and chewing sticks, However, powered toothbrushes are considered best for plaque control.

Clinical Significance:

- Dental Plaque advances into dental caries and periodontal disease, when accumulated beyond normal level.
- Lack of manual dexterity in children poses difficulty in maintenance of oral hygiene.
- Thus, it is important to know various conventional and newer aids to disrupt plaque in children for better maintenance of oral hygiene.

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