# An Inter-Proximal Dental Appliance for the Oral Health Care of Teeth and Gum

## Field of the Invention

This invention relates to an apparatus, appliance or instrument for oral healthcare or dental care. In particular, it relates to a device or tool for cleaning and massaging of teeth as well as gum in inter-proximal or inter-dental regions, among others.

## Background of the Invention

Teeth and gum in human mouth take the form of abutting teeth structures partially embedded in bone while the inter-proximal region between adjacent teeth is generally filled with gingival papilla or gum structure. Viewed from a side, the inter-dental space between two neighbouring teeth resembles a triangle in a region above the healthy gum line. Below the gum line, the inter-dental space looks like furrows extending along each tooth root and separated by a heap of gingival papilla. These furrows of space are referred to as the dental "sulcus" which sit between a tooth and adjacent gingival papilla. Varying in shape at different locations in a mouth, the inter-proximal region takes diverse forms between incisors, canine, bicuspids, and molar teeth. If there has been surgery, disease, poor oral healthcare, or improper developments related to teeth or gum, the gingival papilla and bone structure, which are formerly filled the inter-proximal region, will have deteriorated badly. This will allow an inter-proximal space easily crammed with food particles and fibres, which is difficult to remove, as an excellent breeding ground for bacteria and plaque/tartar/calculus.

It has long been recognised that the accumulation of food particles and fibres around a tooth or above the gum line is a significant contributor to plaque/tartar/calculus associated with tooth decay and gum infections. Toothbrushes, including manual, power driven types, ultrasonic or subsonic

cavitation based, are effective tools for removing food debris or plaque on a tooth's exposed surfaces. However, the region in the dental sulcus between neighbouring teeth where food particles/fibres accumulate is generally too narrow to be reached by a normal toothbrush for effective cleaning. Moreover, it is advantageous to stimulate the gum tissue gently surrounding a tooth for good oral health while a typical toothbrush is not able to provide such care.

There are many devices available for the healthcare of regions in the dental sulcus between neighbouring teeth and gum, including both traditional and modern apparatuses. Traditional devices include inter-proximal brushes and dental floss, etc. have made some forms of improvement over the years. New appliances include water jet based, inter-dental brushes, sonic cavitations dental cleaning tools, etc.

The first type of traditional techniques, dental flossing, is performed by stretching a strand of string, forcing it into an inter-dental area normally from the top of narrow cleft between neighbouring teeth and then pulled back out again via the same route. It is well recognized that flossing is ineffective, inconvenient and difficult to perform. This is because a strand of dental floss has to be stretched tautly by either two fingers or a pair of spaced-apart legs. Thus, it is difficult to take trapped food particles or fibres out passing through the narrow cleft together with the floss.

Various woven, sponged or bonded fibre floss-type linear media are available for cleaning dental bridges and implants. The cleaning effectiveness in using these traditional products tends to be limited because the cross-sectional area of these products has to be reduced when tension is applied. Consequently, traditional fibre-based products have a limited capability in reaching and cleaning areas under bridges and implant prostheses that may be concave or which may have irregular surface contours. Furthermore, fibre-based products tend to snag, fray or shred on sharp edges in the mouth.

The second type of conventional alternative, toothpick is typically a sharp and sturdy elongated tool adapted to be inserted between neighbouring teeth and moved to dislodge any trapped food particles. These products are of (i) softwood or bamboo; (ii) hard moulded plastic; and (iii) moulded rubber. The problem with a toothpick is that it faces the dilemma of making toothpick either too sharp or too thick. On one hand, in order to pick up food debris, the tip of a toothpick has to be sharp and the body of the toothpick has to be slim to be inserted between neighbouring teeth. On the other hand, however, a toothpick has to be thick and sturdy enough to be pressed into narrow inter-dental areas.

The habitual usage of a toothpick tends to increasingly widen the gap between neighbouring teeth. In addition, picking around the gum line often hurts one's teeth & gum due to toothpicks' sharp tip. It is also understood that a toothpick cannot drag food particles/fibres out of a trap; rather, it relies on pushing the food particles/fibres against neighbouring teeth to displace them, mainly depending on friction force. Often, neighbouring teeth or gum are unnecessarily disturbed while the food particles/fibres are still left with its annoying remnant trapped in the inter-proximal regions. Sometimes, toothpick itself is broken or badly deformed during picking.

Recently, a new product (US 2003/0,134,255A1) "Oral-B HUMMINGBIRD", as "power floss and pick" comes to the market. It offers gentle vibration to massage gum and is compact, battery powered with detachable accessories, such as a pick and a flosser for sliding floss along and under a gum-line. The vibration is achieved by a rotary wheel with biased mass driven by a motor. Though with improved gum stimulation function through vibration, "Oral-B HUMMINGBIRD" electric toothpick still has the problem inherited with a conventional toothpick mentioned above.

A new product, Oral-B Pulsar toothbrush, combines toothbrush with toothpick in a single oral healthcare device. Sitting between clusters of bristles, toothpick-like "MicroPulse bristles" incorporates rubberised surface with textured cleaning

pads to penetrate between teeth during tooth brushing. The effect of cleaning the inter-proximal regions is seriously limited since the protruding "MicroPulse bristles" are difficult to aim and enter deep the inter-dental area properly during brushing.

Inter-proximal or inter-dental brushes, as the third type of traditional device, typically comprise fine nylon bristles retained by twisted wire core. Those nylon bristles are normally braided to be perpendicular to the braiding wire and projecting outwards for contacting surroundings. There are many types of inter-dental brushes exist in the market, such as "Oral-B Compact Inter-dental Brush" (US 5,309,596; US 5,377,377). These brushes may be cylindrical or conical in profiles. Inter-proximal brushes typically have several types with a rigid core support:

(i) a brush has its axis set at a $90^{o}$~$100^{o}$ angle to a handle that is similar to a toothbrush handle;

(i) a small, straight inter-proximal brush about 50mm long with a handle normally held between the thumb and one or two other fingers;

(i) tufted brushes such as the market available SULCA-BRUSH; and

(i) plastic foam brushes comprising a plastic inner stem and an outer soft foam cover.

The twisted core wires of many contemporary brushes are coated with TEFLON to prevent irritation of the nerves of teeth. This is because of small electric charges generated in an acid environment (mouth) as a battery effect when dissimilar metals are used in the brush core wires and dental restorations, respectively. The cores of inter-dental brushes are capable of withstanding very limited bending force, the brushes bristles lack durability and the replaceable inter-proximal brushes used with toothbrush-style handles must be changed frequently since food debris trapped among bristles are very difficult to remove. Placing a new inter-dental brush into an existing handle is typically inconvenient and time consuming. In some products, the stem end of

the brush tends to protrude from the back of the handle and must be carefully bent down or to the side to avoid leaving a protrusion that can irritate or even pierce tissue inside the lips or cheek. The core of such brush presents many small crevices that can be infiltrated by micro-organisms. If, as is frequently the case, a brush is used to clean infected areas periodically, the porous quality of the brush has the potential to contribute to periodical infections in a previously infected area of a mouth.

New technology developments in inter-proximal dental care have been realised over recent years. The representative examples of the first group are given in US 3,227,158 and US 3,522,801. These devices offer a narrow and pulsating stream of water to remove material around a tooth. Such devices have to rely on high water pressure with resulting bulky, sophisticated, expensive systems and are also not effective for removing plaque, especially in domestic situations. Sometimes, bacteria spread results from using these items.

US 5,775,346 discloses an inter-proximal dental appliance to be inserted between teeth. It comprises a plurality of elastomeric flat-faced flanges extending perpendicularly outwardly from the base in a staggered pattern. This long string with flat-faced flanges is not to be used for normal, healthy teeth with narrow inter-dental gaps. Instead, it suits more for various types of dental prosthesis, such as bridges and implants.

US 2005/0,037,316A1 discloses an over-moulded inter-proximal cleaning tip for insertion that emphasises on sonic energy based cleaning. The cone-shaped oral healthcare device with flanges is not slim enough to pass through narrow inter-dental regions of a healthy type of teeth, especially at tight upper portion of the space. In fact, the head of such inter-proximal tip has an array of parallel flanges, which are generally perpendicular to the direction of insertion, so that the tip or cleaning head is hindered from penetrating into and/or extracting from narrow inter-proximal gaps. The intention of using those perpendicular flanges is to press onto gum for massaging through vibration. Clearly, this device does

not intend to move the tip into the inter-proximal gaps for cleaning or massaging where pressing on external gum surface can only satisfy part of its massaging purpose. The gum inside inter-proximal regions, or between neighbouring teeth, is largely ignored. There is no cleaning purpose or structure for this device presented.

In addition to inter-proximal cleaning, US 4,660,583 discloses an inter-dental stimulator in the form of elongated member. This is asserted as an improvement to the market available product, namely STIM. U. DENT. This inter-dental stimulator has a slender tip for insertion and gradually expanding body for massaging. The entire device or medial portion is a single solid elastomeric piece with no gap. Since this device is not able to expand laterally, it relies on a gradually enlarging body as a cone profiled body to match changing profiles of inter-proximal regions. This type of device cannot be used for inter-dental cleaning as their main structure and function are designed for massaging to gum only.

Some of recently developed dental care appliances are equipped with sonic power generator to promote effective dental hygiene, including power-driven toothbrush, tufted brushes, pick-type members, and inter-proximal brushes. Though these devices have shown improvement in cleaning efficiency, they have limitations in lifetime and are effective in special occasions only. For examples, tufted brushes are not effective for disrupting plaque from inter-dental space, whereas the pick-type member is hazardous to a healthy set of teeth and gum as afore-discussed.

The known and readily available devices for inter-proximal cleaning, as mentioned above, are typically manually operated and require great adroitness as well as patience to successfully clean the teeth. Accordingly, there is still a need to have an easy-to-operate and effective cleaning appliance for inter-proximal places. None of currently available instruments is capable of effectively promoting complete oral hygiene.

While each of these inventions offers one or more novel features directed at overcoming the limitations or short-comings of the traditional approaches, each of these products present, individually or collectively, limitations that fail to satisfy all of the criteria for a clinically effective inter-proximal cleaning product necessary for gaining wide acceptance by dental professionals, dental patients and normal users.

The present invention is directed to provide advantages, overcome, or at least reduce negative effects of one or more of the problems presented above.

Summary of the Invention

The present invention aims to present a new and useful apparatus for inter-proximal cleaning, massaging or treatment, as well as new and useful methods for using the apparatus for oral hygiene and healthcare, including teeth and gum.

It is an object of the present invention to provide an inter-proximal oral healthcare tool or appliance that is easier to operate and more effective to clean or massage for the oral health of teeth as well as gum.

In general terms, the present invention brings in an inter-dental oral healthcare tool which may be able to adapt to its inter-proximal surroundings by lateral expansion or contraction. This laterally self-adaptive device make it possible to suit changing and complex inter-proximal regions as well as keep sufficient contact for cleaning, massaging or other medical treatments.

To achieve the above-mentioned objectives, according to one aspect of the present invention, a device for oral healthcare may have a front end for inserting into an inter-proximal region; a back end for applying an insertion force; a medial portion between the ends; and elements of the medial portion

that contact the inter-proximal region are aligned to a direction of insertion for guiding; wherein the medial portion is able to expand or contract laterally when moving inside the inter-proximal region. Here, the inter-proximal region can also be interpreted as a gap or (inter-dental) surroundings for insertion. It is possible that only some elements of the medial portion aligned to the direction of insertion are sufficient for guiding the insertion, although all elements aligned may be easier for insertion. Multiple elements or an element together with a central supporting shaft (also as an element here) may help to capture food debris between a gap of the elements. There may be certain stiffness required for the assembly of the device, especially for the medial portion so that an insertion force exerted to the back end can be transmitted to the front end for penetration. If those elements, which contact inter-proximal surrounding during application (e.g., cleaning, massaging, etc.), are aligned substantially perpendicular to the direction of insertion, they can possibly hinder the proper insertion and prevent large or major part of medial portion from touching inter-proximal surroundings. If the medial portion is not aligned to the direction of insertion, the medial portion may be good only for massaging gum at the gum's exposed area. Non-proper alignment of the medial portion may prevent proper inter-proximal cleaning for the unexposed inter-proximal regions between neighbouring teeth. For the reason of getting medial portion to contact inter-proximal region/surroundings properly for the device, the medial portion may be made laterally expandable, contractible or both and this is especially important for the contacting to happen when the device is inside or within the inter-proximal regions. Proper and sufficient contacting facilitates its scouring, capturing food debris, massaging or other activities where a device, which is not able to expand or contract laterally (e.g., a typical toothpick), may not be able to take care of its surrounding properly in an efficient manner. The property of lateral contraction may allow the device to reduce cross-sectional area in the direction of insertion during a penetration process and permit the cross-sectional area to enlarge for contacting surroundings when it is already inside inter-proximal regions. Here, lateral expansion or contraction does not have to be accompanied by the change of distance between two ends of the

elements forming the medial portion. For an example, the elements may be an array of fins or filaments/strips aligned to the direction of insertion, a few resilient filaments or a spiral thread, etc. Filaments for the arms around the core support may be advantageous because gaps/voids provided between those wires/strips/fins and the core support which form the medial portion enable the device to capture food debris. Moreover, gaps/voids provided may allow fins/arms to be folded to reduce device's lateral size. On the other hand, fins around a core support, which are possible to be folded down on the core support when pressed/resisted by inter-proximal surrounding, makes more comfortable scouring around inter-dental regions possible because a fin has larger area than a wire with the same outer contour. Both fins and filaments can be arranged in stagger, waving, or any other suitable arrangements, which are possible to laterally expand or contract. Alternatively, the gaps/voids may take the form of a fluid filled balloon where the interior of the medial portion is filled with pressurised gas/es or fluids.

A preferred embodiment may have the medial portion to include at least one laterally expandable or contractible fin. The fin can also be termed as arm, wing or member. Such device may permit those fins collapse onto a central core support when it is restricted by surroundings inside an inter-proximal region so that the area perpendicular to the direction of insertion is reduced which helps piston type of movement as penetration and extraction. At the same time, those fins may keep contacts with surrounding due to their resilient nature. The cleaning or massaging is thus possible to be accomplished when the device moves its medial portion between teeth or gum.

Another preferred embodiment may have the fin formed by a sheet or in a sheet form. Those (moulded) fin/fins with continuous surfaces may resemble spades which enable scrubbing activities on teeth and gum surfaces for cleaning and massaging. A fin's surface may be textured, perforated, or with saw teeth type of edge which scours teeth or gum surfaces more effectively.

Another preferred embodiment may also have the fin formed by a filament or strip. In addition to scrubbing actions, gaps between neighbouring filaments or its core support makes it easier to grasp unwanted food particles for inter-dental cleaning. Filaments or strips are also possible to be formed in saw teeth type of profile. Strip may differ from filament by having breadth in one orientation being broader than the other, such as oval cross-sectioned strip. Filament may have substantially similar breadth in all its lateral directions, such as a circular cross-sectioned wire.

Another preferred embodiment may have a resilient shaft connected to the fin/s for supporting. There can possibly be multiple such shafts connected either to one or more fins. This may help the medial portion to bent or curve to suit changing profiles of inter-dental areas.

Another preferred embodiment may have the core support be a resilient tube. The tube provided may or may not have its front or/and back ends opened. Besides, the core support body may be perforated. These features may facilitate discharge of certain liquid for treatment, cleaning etc. Moreover, a resilient core support in a tube form may be squeezed to collapse for reducing its lateral cross-section area so that bending and insertion/extraction are made easier.

Another preferred embodiment may have the medial portion to expand or contract laterally by changing a distance between the ends. A special advantage may be achieved because elements of the medial portion can possibly extend longitudinally in the direction of insertion to absorb the arm's transformation when they are compressed in lateral directions of the device. This can possibly prevent the elements from being squeezed to one end excessively or stress inter-proximal surroundings by laterally deformed medial portion. In other words, the change of distance between the front and back ends may avoid the accumulation of material of an arm at a certain location when the arm is required to subside or straighten laterally. By adjusting the

allowed range for the variation of effective distance, which is the distance between the front end and back end of an element or medial portion, a user is possible to regulate the resulted lateral force.

Another preferred embodiment may have its medial portion to expand or contract resiliently. Other than resilient movement, expanding or contracting can possibly be achieved by a structure used in an umbrella where the umbrella can change lateral coverage or breadth by the movement of a lower nest along the straight rod. In this case, elements of the medial portion may be rigid and still allow the medial portion to expand or contract laterally. On the other hand, a resiliently expandable or contractible/reducible body may be more preferred because it possibly enables the device to touch its surrounding without always being adjusted by a user. A resilient member is a commonplace, such as a stainless steel wire, nylon filament, etc and they may cost little.

Another preferred embodiment may have the medial portion to expand or contract by relative rotational movement between the ends around an insertion axis. In other words, a rotation of the front or back end may cause the medial portion to be stretched in a helical manner so that it may wrap around the core or themselves although actively rotating the back end may be the more preferred option for construction purposes. The insertion axis pointing in the positive direction of insertion, for the convenience of discussion, is made to be the X-axis in a 3-Dimensional Cartesian co-ordinate system. This is a possible alternative to reduce or enlarge the lateral profiles.

Another preferred embodiment may have at least one element be flexible. Flexible members can be similar to dental floss, which may not able to keep a default or rigid form, unlike resilient elements. However, a plurality of such strings connecting the front and back ends individually may still help inter-proximal cleaning when they rotate with a supporting rod in the middle as core support. Here, a string links the front and back ends may be more preferred to

be longer than the direct distance between those ends of the device so that the floppy string may sag when it is outside the inter-proximal regions where there is no external support. Therefore, the flexible member in forming the device may achieve cleaning benefits to a limited extent.

Another preferred embodiment may have at least one element be resilient. Normally, a plurality number of resilient elements (e.g., string, strip, thin rod, tube, flat bar, etc.) are used so that they form a bouncing body around the device's central axis, namely X-axis. Those elastic and springing arms/members may enable some of the principle functions of the device as capturing food particles, massaging and scouring teeth/gum. One or two such resilient member may also perform some of the functions when the device is allowed to rotate, either passively by its contact with surrounding or actively by a motor driven.

Another preferred embodiment may have the element be a tube. A tube structure of the element, either as flexible or resilient member, may allow a smaller magnitude of expansion or contraction of its own body. Besides, if there is some fluid dispatched through the tube, the device may further help cleaning or treatment in inter-proximal regions with some medicaments.

Another preferred embodiment may have resilient tube element to possess one or more openings at its front end, back end, on its lateral surfaces or in combination of any of these. Those elements, which surround the central/insertion X-axis of the device, may have openings at their various places, such as front or back ends, or on their side surfaces so that injected fluids may be released through those perforations to enhance cleaning as an example.

Another preferred embodiment may have the element braided with bristles or other forms of small protrusions. This may allow those elements/arms to scrub in the inter-proximal regions better with those small lumps, pricks, etc. Braided

can also possibly be interpreted as planted, woven or other suitable techniques.

Another preferred embodiment may have the element to comprise a plurality of layers of materials. Some layers with soft-touch on the external surface are desirable for contacting gum while a stiff core is better for a member's profile support. Multiple layers of coating and overlaying build better quality member for many situations, such as hygienic, versatile profile requirements.

Another preferred embodiment may have the elements either uniformly or in an unsymmetrical manner distributed around the insertion axis. A balanced/uniformed circumferential distribution of members around the lateral direction/plane can possibly enable balanced rotational movement while purposefully leaving some openings/gaps/voids around circumferences to catch food particles better.

Another preferred embodiment may have treated materials for arms/members/elements, such as minted, flavoured, medicated, or quasi-medicated materials. This feature can possibly provide attractive feeling or healing effect when a user put the device in contact with his/her oral surroundings.

Another preferred embodiment may have the element either completely or partially sleeved with additional materials, such as rubber, polymers, biocompatible or degradable materials. Here, the additional material can possibly be the material which makes the element itself but with extra features, such as geometrical or colour related, etc. A partially covered member, such as front smooth finish while middle sleeved with textured rubber, may provide smooth entry or insertion using the front portion, as well as effective scouring using the middle/medial/intermediate portion.

Another preferred embodiment may have the element be a membrane. One or more thin, continuous layers of material are possible to provide uninterrupted touch with gum by the device and it may be very suitable for infected, fragile, sensitive gum.

Another preferred embodiment may have the interior of the membrane enclosed by the membrane filled with treatment materials, such as medicaments, soothing gel, or other fluids. During the treatment of infected areas, those contents may be gradually released so that infected area will be healed faster.

Another preferred embodiment may have the external surface of the membrane be textured, roughened, porous, scattered with nipples/bumps, short spikes, grooves, spiral channels, flanges, threads, or other undulating structures, etc. Those additional features on the external surface are possible to assist penetration, rubbing and tapping, etc.

Another preferred embodiment may have the membrane be resilient, inflated (as a balloon) or in combination of these. For an example, the membrane that forms the medial portion can possibly be supported by resilience of the membrane itself. Alternatively, if the membrane forms a sealed body or multiple layers sealed body, the interior of the membrane may be inflated or pressurised. A combination of inflated or resilient medial portion is also plausible. This may make a balloon type of device, whether it is filled with some pressurised fluid or not. This bouncing structure may ensure good and continuous contact with its surroundings when it moves inside inter-proximal regions or gum lines.

Another preferred embodiment may have the device attached to or detached away from a handle. This may be a very useful feature as the detachable device can possibly be recycled, disinfected, or simply replaced by another one. Since proper oral cleaning demands highly hygiene conditions, a

replaceable/detachable device for disinfection may be much desired. It may also prevent unnecessary wastage of good handles, especially when the handle is equipped with sophisticated control or medicament content supply means.

Another preferred embodiment may be integrated with a handle. For some simple or low cost devices, a device integrated with a handle may be suitable for one-off/time (disposable) usage, which may be appropriate for travelling applications.

Another preferred embodiment may have at least one core support along the insertion axis. The core support may allow the distance change between two ends of the medial portion. A core support for the device may be similar to the function of a pillar which erects the device with proper resilience and stiffness. It may also provide a central support for bending, rotating or twisting, etc. The core support may be tube-like or perforated so that fluids can be supplied through it.

Another preferred embodiment may have one end (e.g., back end, front end, or both) of the elements connected to a slider that is possible to move (e.g., spiral progression, linear slide, etc.) on/along/around the core support. In this case, the back or front end of the device may be separated into two parts where one part is still possible to receive an insertion force while the other guides or carries the medial portion of those elements along the core support. Allowing the front end to move along the core support is also possible but it may not be the most desired because this may prevents the medial portion from entering inter-proximal regions or complicated the structure. A movable slider may give additional means for adjusting lateral profile of the device. A possible distinctive advantage of this arrangement is that the resilient members themselves do not possibly compromise the stiffness for insertion purpose since the lateral expansion force is also possibly controlled by the slider's

position on the core support, in addition to the resilience of the elements themselves.

Another preferred embodiment can possibly have the slider be set/affixed/locked/adjusted to certain positions on the core support. This means that the device may be pre-set or locked, such as for certain profiles of the device which in turn may give certain stiffness of the members of the device for results or comfort.

Another preferred embodiment may have the slider be rotated/twisted around the core support, moved along the core support, or both. Bring the slider closer to or further away from the front/insertion end from the back end may regulate lateral profiles of the device. The twisting motion may be achieved by propelling the slider along a threaded or a twisted bar, pre-setting/locking the back end with some stoppers/clips, which is possible to result customised/customisable lateral profiles.

Another preferred embodiment may have the core support be perforated at the end or/and on its lateral surface for delivering fluids. As mentioned earlier, openings on the core support may permit some release of certain medicines or pressurised air for blowing. In addition, when required, those holes may be used for suction during cleaning as unwanted fluids can be taken away.

Another preferred embodiment may have the device be rotated passively for contacting its surroundings. The passive rotational movement is possibly performed by the contact or friction between the device and its surroundings, such as teeth and gum. In other words, the base of the device may provide freedom for the device to swivel and change revolving positions with respect to the axis of insertion although no active driving mechanism, such as a motor is provided. Such repeated insertion and extraction may enable capturing food debris especially when it rotates for complying resistances and surrounding profiles.

Another preferred embodiment may have the device be rotated actively by a driving mechanism. The driving mechanism used for active rotation for the device, such as an electric motor, a mechanical winder, or pressurised gas powered turbine, and their related transmission systems, etc. may enable mechanisms for continuous souring, massaging, or cleaning. The electric motor may also serve other purpose, such as pumping, vibrating or sucking, etc.

Another preferred embodiment may have the rotation be controlled manually, automatically or in combination of both. In other words, the triggering of rotation of the device can possibly be a pushed button, which let the device rotate when required. Alternatively, certain patterns of rotation may be preloaded to the memory of microprocessor/s equipped device as recommended rotational models to user, which may allow a user to pick up some manufacturers, with recommended cleaning procedures, etc.

Another preferred embodiment may have the device be able to vibrate. Proper vibrations may enhance the effect of massaging and cleaning.

Another preferred embodiment may have the device to vibrate below sonic frequencies. Low frequency vibration may be good for dislodging tartar or taints off a tooth's surface better.

Another preferred embodiment may have the device be able to vibrate above sonic frequencies. Ultrasonic vibration is possibly very suitable for removing stubborn debris. Care may be exercised by trained personnel to prevent cutting into soft tissues.

Another preferred embodiment may have the device be able to vibrate at low audio frequencies, such as between 20 to 400 Hz. Within this range, it is

observed that the cleaning effect for teeth is possibly markedly better or suitable than other ranges.

Another preferred embodiment may have the device be able to vibrate at 350 ± 25 Hz. Considering the actual mechanism for vibration, such as by a rotary wheel with biased mass, this preferred range of vibration has been observed as possibly very suitable for inter-proximal cleaning.

Another preferred embodiment may have the device be able to vibrate continuously, intermittently, or follow a pre-determined pattern. Many patterns of rotation (e.g., continuous, intermittent, etc.) may be possible to enhance the cleaning result. Some patterns of vibration require combinations of various suitable masses, sizes and profiles which may achieve cleaning/massaging effect in a more effective manner.

Another preferred embodiment may have the device be able to vibrate with an amplitude of 2.5 ± 2mm, frequency around 250 ± 50Hz, instantaneous velocity at an arm 1.5~3.9metre/sec, or in combination of any of these. This set of parameter may possibly be suitable for the proposed size of the device in getting better results. Moreover, it is also possible to enable a microprocessor equipped device to execute routine operations without user' tedious adjustment.

Another preferred embodiment may have the device be able to release a material, such as gases, solids, semi-solids, fluids or in a mixture of any of those. Solids as salt powders or smoke, fluids as treatment liquid (e.g. oxygen enriched water, salted water, etc.), or gases (e.g., air, fog), or multiple phases mixture (e.g., bubbled water) may be in forms of some medicament administered directly to infected inter-proximal regions. Toothpaste may be allowed for a user's own application if the sachet or pocket is provided in a connected handle for discharging. Sachet or pockets filled with treatment

material for the device delivery or discharge may be sold separately for user to attach in the handle.

Another preferred embodiment may have the device be able to release a healthcare material, such as water, gel, anti-bacteria mouthrinse, medicaments, toothpaste or the like. Specially prescribed medicaments or gel housed at the interior of the device (among resilient members) or supplied via an auto/manual pump may target specific oral diseases so that the device may be used as a domestic appliance, as well as a medical tool or equipment.

Another preferred embodiment may have the device to take contracted or expanded profile during insertion or idle mode/status/process. Both of these profiles enjoy many possible advantages during insertion or idle mode. For example, a constrained lateral profile may make insertion and rotation much easier. When the contracted/constrained device enters an inter-proximal region first, experiencing less resistance, can possibly expand later to capture dirt or food debris when in place. On the other hand, an expanded profile may scrub better when it is in the process of entering inter-proximal gaps and it may also offer sufficient touches to its surroundings. Manufacturers may keep both options open to allow users to select the best mode for themselves for each device and this may be done by setting an appropriate effective distance.

Another preferred embodiment may have the expanded profile to take the forms of an olive stone, rhombus, triangle, rectangle or the like. Those shapes may naturally allow the laterally expandable or reducible body to regulate its shape in a convenient manner. Besides, those profiles may ease the insertion and extraction of the device.

Another preferred embodiment may have at least a portion of the member's cross section be circular, oval, rectangular, square, hexagonal, twisted polygonal bar or the like. The cross-sectional area/shape of the members may

further help scrubbing, cleaning or massaging without compromising of resilience/stiffness of those members or being too sharp at their edge.

Another preferred embodiment may have the front end having an additional guiding means to ease insertion. This is because a hard front end possibly makes smoother insertion especially with certain geometries' or profiling help.

Another preferred embodiment may have the guiding means as a portion of thread, fin, cone, sphere, oval, or other shapes. These examples of geometries may provide some better guidance, may be accompanied by rotation of the device, for soft insertion and extraction in the inter-proximal regions.

Another preferred embodiment may have the device being capable of swinging with respect to its supporting handle in various directions, passively, actively or both. This can possibly prevent a rigid connection between a handle and the device. When moving around in one's mouth, a flexible connection of the device to its handle may permit less restrained handling of the device. The device may be actively swung by a motor driven cam or passively a bouncy base. The active swinging may allow the device to have extra manoeuvre opportunities for more complex cleaning or massaging.

Another preferred embodiment may have the medial portion be coated, such as by TEFLON, plastic, or other suitable coatings. Coating may serve smoothening or hygiene purposes, etc. Coating may also allow one to make use of hard filaments with soft external surfaces for comfort touch.

Another preferred embodiment may have the device be equipped with sensors for automation, such as load/force sensor, speed sensor, pressure sensor, proximity sensor, displacement sensor, stress/strain sensor, noise sensor, vibration sensor, other sensors or the like. Those sensors are possible to monitor pressing force, movement situations and other parameters so that manufacturers may prescribe optimal cleaning or massaging patterns for

different user groups. For an example, a manufacturer may even provide a timer so that user may be alerted with usage time at every session or time to replace the device. This may be suitable for some advanced versions of the products, which apply regulated force or cleaning pattern to certain scenarios. Load sensor may help to prevent disproportionate insertion force; speed sensor may help to prevent excessive rotational speed; and other types of sensors may be incorporated together with those sensors and regulated by a microprocessor, or the like.

Another preferred embodiment may have the device be connected to a filled bag, sachet or pouch for automated or manual discharging through the device to teeth/gum. Often, this may require a handle equipped with pumping means or attachment means (e.g., pressurised gas/es) so that those contents in bags or sachets may be applied to teeth or gum for cleaning, polishing or massaging.

Another preferred embodiment may have the device operated being operated corded by using external power supply (e.g., 110/220V from mains), cordless by using internal power supply (e.g., 3V/9V by batteries) or in combination of these. This may add a power supply for such device, e.g., rotation of the device, can possibly be made via a cable connected to mains, re-chargeable batteries, alkaline batteries powered system, etc. With a battery, such device can possibly be made portable with an electric motor.

Another preferred embodiment may have the medial portion be made of medical polymers, or biocompatible materials. A biocompatible material for the device may be essentially inert. Biocompatibility can possibly be described as "the quality of not having toxic or injurious effects on biological systems", such as an injection moulded from biodegradable polylactide (PLA). On the other hand, some biodegradable materials can also possibly be adopted. Both biocompatible or biodegradable materials may be used for the device with extra benefits of hygiene and health in the long term.

Another preferred embodiment may have at least one smaller device, termed as a device unit for the whole device assembly, nested inside another. This may make a device (unit) within a device possible and the assembly of the devices forms a single device. The possible benefits of using a larger device with preferably less filaments for capturing food debris are integrated with a smaller device at the interior with more filaments for better scouring and massaging.

Another preferred embodiment may have an external device unit be allowed to have relative movement with respect to its interior device unit, such as linear movement, rotation, expansion, or contraction. For an example, the movement of the larger exterior device may not necessarily disturb the inner smaller device, and vice versa. Independent movement of those multiple devices may promote their respective functionalities to the possible full extents.

Another preferred embodiment may have a plural number of device units mounted serially on the core support. In this manner, multiple devices may be curved or bend at their contact point so that it fits complex oral surroundings better.

Another preferred embodiment may have the elements be able to be repaired/replaced for repairing or exchanging. For some durable type of device, a broken member, whether it is resilient (bouncing) or flexible (non-bouncing) type, it is desired for a handy user to fix it or add extra feature on his own.

Another preferred embodiment may have the device being able to be reused after a sterilisation or disinfection process, such as hot water boiling, medical alcohol cleaning, ultraviolet light exposure, dishwasher cleaning, microwave treatment, etc. Sterilisation processes are especially important for users with oral diseases. Sterilisation can possibly prevent secondary infections or even passing bacteria to potential close people.

Another preferred embodiment may have a plurality of such device units be connected serially either by a flexible or resilient filament. This type of arrangement resembles a dental floss except there is stiffness or tension between ends of each little device. This can possibly help to maintain expanded lateral profile for inter-dental cleaning when it is pulled through inter-proximal gaps.

Another preferred embodiment may have a frontal device unit smaller than some others device units of the device assembly. If a plurality of device units (e.g., 2 laterally expandable/reducible device units on a single rod for forming a single apparatus) are installed serially on a stiff shaft/rod as a core support, especially when the front device unit is made smaller than the back (e.g., 3 or more times smaller), the device assembly with a plurality of device units is possibly made easier for cleaning both smaller regions using the front device unit and larger regions with the back device unit/s. This type of configuration may enable the front smaller laterally expandable device unit to scrub some narrower, healthy inter-dental gaps, and also may be accompanied by the large portion of such device assembly (the back device unit) for broader areas.

Another preferred embodiment may have a plurality of such device units connected in parallel. This type of arrangement may allow a single tooth wrapped by two of such device units so that a single standalone tooth, which happens in certain people with poor oral situations and larger inter-proximal cavities/gaps/regions, may be cleaned properly with such multiple device units array.

According to another aspect of the present invention, a method for oral healthcare may be using the device. The method employing the device may provide more effective and efficient cleaning, treatment or massaging for the oral health of teeth and gum.

The foregoing and other objectives, features and advantages may become more apparent in the following detailed description which proceeds with reference to the accompanying drawings.

## Brief Description of the Drawings

While the specification concludes with claims particularly pointing out, which is regarded as the present invention, the advantages of this invention may be more readily ascertained from following descriptions of the invention when read in conjunction with the accompanying drawings in which:

Figure 1 submits a right-hand Cartesian co-ordinate system for a three dimensional space for each device with positive X-axis direction as a direction for insertion. A side view and a top view for each example are laid next to each other;

Figure 2 gives a laterally self-adaptable oral healthcare device which has only one filament arm and one core support as an example of simple configurations;

Figure 3 reveals a laterally expandable and reducible oral healthcare device without having a joint front or back end;

Figure 4 gives a top view for the device with multiple filament arms as a representative example of the device;

Figure 5 presents a top view whereby the oral healthcare device is in the process of cleaning and its intermediate/medial portion is compressed by neighbouring teeth;

Figure 6 depicts the oral healthcare device with various possible patterns of filament arms;

Figure 7 illustrates the top views of some examples of the laterally self-adaptable oral healthcare devices with various shapes, including substantially rhombus, triangle, oval, and rectangular, etc;

Figure 8 demonstrates the laterally self-adaptable oral healthcare device having an American Football profile while its tip having some over-moulded threaded shapes or flanges for guiding the insertion;

Figure 9 offers a top view of the membrane formed laterally self-adaptable oral healthcare device body filled with certain liquid/s and its front end is equipped with a moulded cone to guide the oral healthcare device for entering inter-proximal regions;

Figure 10 describes a self-adaptable oral healthcare device whose arms and core support are in the form of tubes for delivering certain fluids;

Figure 11 portraits a multi-elements/filaments formed laterally self-adaptable oral healthcare device whose base facilitates it to swing within certain range so that it is able to be inserted into an inter-proximal region easier at various places or orientations;

Figure 12 renders a laterally self-adaptable oral healthcare device having a slider coupled arrangement and the slider progresses along the core by threads for adjusting the lateral expansion force and profile;

Figure 13 represents an oral healthcare device whose resilient arms substantially attached closely to the core when it is idle. The lateral expansion of this oral healthcare device is achieved by either drawing the back end towards the front or pulling the front towards the back;

Figure 14 tenders the view of a self-adaptable oral healthcare device whose body is allowed to be rotational around the insertion axis-X either actively or passively;

Figure 15 submits an example of a detachable oral healthcare device where the oral healthcare device assembly is made able to be dislodged and coupled to a suitable handle;

Figure 16 puts forward an oral healthcare device which is capable of releasing medicaments (gas, liquid or any mixture/s) or other materials to enhance its cleaning, massaging and/or healing abilities;

Figure 17 makes known a nested type of oral healthcare device where a smaller device is housed within a larger device;

Figure 18 proffers multiple device units serially connected to form a single device with certain stiffness in the insertion direction for exerting an insertion force by a handle;

Figure 19 introduces a cleaning tool assembling a series of suitable sized self-adaptable oral healthcare device to a linear medium (e.g., a string) so that it is able to pass through and/or move around orthodontic brackets and wires; and

Figure 20 exemplifies another type of using multiple self-adaptable oral healthcare devices in parallel formation, which is able to conform to larger inter-dental regions.

Detailed Description of Some Preferred Embodiments

The present invention/s will now be described more fully hereinafter with reference to accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in different

forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

Some preferred embodiments of the oral healthcare device possess a number of important characteristics for its operations. Elements or arms, which form the laterally adaptable body of the oral healthcare device, are preferred to align to the direction of insertion. Besides, it is not desired to have the resilient structure/device body only expand or contract in one fixed orientation with respect to its handle or back end, which limits or even defeats the purpose of expanding or contracting to adapt the surrounding and capture food particles. In other words, the device is preferred to expand or contract laterally in unfixed, sundries of directions, possibly accompanied by the reciprocal movements of insertion/extraction or rotations in/inside the inter-proximal regions. When thin, narrow, and sturdy resilient filaments/strips are used, they may cut into soft gum unless it can rotate in inter-proximal regions and avoid having narrow, sharp edges. When using flat strips as resilient arms to construct the laterally expandable and contractible medial portion, those strips should not prevent the device body being able to rotate inside usually narrow inter-proximal regions. The dental healthcare device has sufficient longitude stiffness for the device to be inserted into inter-proximal regions under some resistance. In other words, a long, floppy or thin string, such as a dental floss or the like, is not able to be inserted by exerting an insertion force at its back end. The moment of inertia about the lateral principal axes is preferably to be similar in both lateral axes' directions so that the device may rotate in sundries of directions or positions. A device possesses biased moment of inertia about its lateral principal axes hinders proper rotational movements and is not suitable for cleaning or massaging. Moreover, if a device can only expand or contract at an instant moment during an insertion or extraction process, rather than expand or contract when it is inside or in an inter-proximal region already, the said device is not able to provide sufficient contact between its body/arm with inter-proximal

surroundings for effective cleaning and/or massaging. If a device which is not able to change the distance between its front and back ends, it has to rely on its arms to yield its profile greatly for easier insertion. Therefore, a device expands or contracts laterally by allowing the change between its front and back ends is a preferred option, either with or without a core support.

To clarify the orientations of the oral healthcare device, a right-hand Cartesian co-ordinate system for a three dimensional space is employed as shown in figure 1. The insertion direction for the device to enter an inter-proximal region is in the positive X-axis direction or the longitudinal direction termed as the first principle direction, while other two principle axes Y and Z determine lateral directions. In other words, the lateral directions are those inside the planes determined by axes Y and Z.

According to some preferred embodiments, the oral healthcare device forms a laterally expandable and/or reducible structure which is capable of being inserted and/or extracted into inter-proximal regions in sundries of orientations for cleaning, massaging, or treating (healing) teeth and gum. The laterally expandable and reducible oral healthcare device is able to conform or adapt to its surrounding spatial limitations formed by neighbouring teeth & gum and rub & massage those parts. Normally, expanding or contracting actions are able to be carried out in both lateral planes determined by Y & Z axes. The resilient arm/s or membrane/s forming this laterally expandable or/reducible structure help to engage or capture food particles or debris and remove those unwanted stuff out of inter-proximal regions. Those elements that form the medial/intermediate portion between two ends of the device are required to be aligned to the direction of insertion so that the penetration of the device is made easier. The oral healthcare device is preferably to be held to a handle free to swivel for more convenient and effective operations. The oral healthcare device can also adopt various other movements and operations to further enhance its performances.

Sometimes, some preferred embodiments of the healthcare device takes an expanded profile when it is idle or in the process of entering the inter-proximal regions. On the contrary, in other embodiments, the oral healthcare device takes a thin, constrained profile when it is idle or in the process of entering the narrow inter-proximal gap. Thirdly, an embodiment which allows both expanded and constrained lateral profile during insertion, depending on manufacturer's specification or user's requirements, is also permissible. In these three types of embodiments, the oral healthcare device is able to expand as well as contract in a controlled manner (e.g., shrinks the medial portion before the device contacting any surroundings) or when required to conform to surroundings if necessary (e.g., the medial portion is reduced only when the device is squeezed by surroundings). The expansion or contraction can either be achieved by resilient properties of those resilient members themselves or with the help of a core support of the device. The distance between the front and back ends of the device, which is termed as effective distance, is preferred to be adjustable to realise lateral expansions and contractions of the medial portion. To allow the arms or body/ies of the device to be laterally expandable or contractible, the medial portion is preferred to be filled with certain fluids, such as air gaps between the arms.

According to the embodiments shown in figure 1, a number of examples are given for the device as having one or more of filaments (2, 4, 14) or fins (2, 4, 14) distributed around a core support (31). For every device presented in figure 1, the left-hand side is a top/side view of the device while the right hand side is a front view of the device viewed from the left (negative X-axis direction). Those filaments (2, 4, 14) or fins (2, 4, 14) can be made by stainless steel wire as their contours or thin silicone rubber as their fin sheet areas which both can collapse or fold onto the central shaft (31) when experiencing constrains laterally. During an insertion, those arms (fins/filament wires) (2, 4, 14), which are aligned to the direction of insertion direction as X-axis, guide the penetration process and reduce resistance. When inside inter-proximal regions, those fins/arms (2, 4, 14) will stand against their surroundings for

rubbing or cleaning. Profiles of an individual arm (filament or fin) (2, 4, 14) can vary as well as the pattern of multiple arms (2, 4, 14) when certain designs are preferred. When the device move, either rotates or displace in a linear manner, the laterally expandable device rubs the teeth and gum so that cleaning and massaging actions are carried out. Arms can also be made in the form of a thread or threads (14), whether it is formed in the form of a fin (continuous sheet) or a wire, which help to guide insertion if rotated. The lead or helix angle of the thread is preferably to be between larger than 45° so that the threaded device may enter inter-proximal regions easier. For the same reason of easier entering, the front portion of the device is preferred to have filaments/fins/threads with lower height (smaller lateral width/size) while the middle or back portion of the device is preferred to have higher fins/thread (larger lateral width/size) to help insertion. Variations of arm/s pattern are possible for making the medial portion.

Referring to figure 2, the laterally adaptable body of the oral healthcare device (18) is simply formed by a single resilient arm (3) and a core support (31). This device (18) has a narrow front end (1) for insertion and a back end (5) joining to a base (6) on a handle. The arm (3) and supporting core (31) is allowed to be rotated around the base (6) so that this body is allowed to be inserted into inter-proximal gaps in sundries of direction or orientations. The back end (5) may be allowed to glide along the core support (31) so that the resulted deflection (change of curvature) of arm (3) changes lateral profile of the device (18) to adapt inter-dental regions. The core support (31) may be taken off but this may impair the performance of the device (18).

To give more lateral coverage around the insertion axis-X, multiple arms formed device is preferred. Referring to figure 3, an embodiment (16) has multiple arms without joining front and back ends is shown. In the example given in figure 3, the oral healthcare device (16) has its elements (3) detached from each other for lateral expansion and reduction. The font (1) and back (5) ends are not joined. The mode of laterally expansion or contraction of this

device (16) is rather similar to opening or closing of an umbrella where the relative movement of the core (31) with respect to arms/elements (3) in X-axis direction causes the ribs (20) to adjust the device (16) lateral profile. Normally, this oral healthcare device (16) is preferred to enter narrow inter-proximal regions with its constrained profile first where all arms (3) are closely attached to the core (31). Later, when the medial portion is already inside the inter-proximal regions, it can expand and conform to the surroundings, possibly combined with reciprocal movement or rotation, for cleaning and massaging.

According to an embodiment shown in figure 4, the oral healthcare device (9) comprises a number of mutually independent resilient wires/strips/filaments (3) joined at both ends (1 & 5) while the middle/medial/intermediate portions between two ends (1, 5) of every arm/filament (3) spread apart from each other (with gaps or voids in-between) and are curved similar to the shape of arcs, deflecting outward. In the following descriptions, element/s, filament/s, wire/s, strip/s are used interchangeably in some situations while an arm (3) is a more general term to describe a resilient/flexible member (3) for building the device (9). The front end (1) of the wire/strip cluster (9) is normally made small and smooth to ease its slipping through (25) the narrow inter-proximal area while the back end (5) holds resilient elements/arms (3) together to a supporting base (6) or/with a handle (7). The wires/strips cluster (9) thus takes the profile resembling an olive stone or an American football, though slimmer in some cases. When in use, the narrow, smooth tip (1) can be located near a sulcus and pushed forward (25) (see figure 4). Thereafter, the oral healthcare device (9) contracts at its lateral directions (24) due to constrains given by neighbouring teeth (13) to adapt to the changing form of furrows of surroundings. The resilient and self-adaptive body (9) of such wires/strips cluster (9) ensures its body's (9) constant touch with both surrounding teeth (13) and gum. Consequently, reciprocal movements (27) as insertion and extraction of this oral healthcare device (9) between neighbouring teeth (13) and gum gives more effective teeth cleaning and gum massaging.

The cross section of every individual resilient element (3) can have many shapes depending on different usage and construction requirements. Different arms of a single oral healthcare device may have various types of finish, cross-section with certain regular or irregular arrangement. Such arrangement allows certain arms with better scouring ability installed together with certain arms with better massaging arms so that the total effect of massaging and cleaning can be enhanced. For an example, a circular shape with broad a diameter (e.g., Φ0.6~1.2mm) prevents cutting into gum, especially when gum is inflamed. An oval cross-sectioned element (boarder in one lateral direction only) gives better scouring ability if the narrower side is contacting surrounding or gives better massaging ability if the boarder side is contacting surroundings. The appropriate selections of cross-sectional shape and orientation of those arms further add oral healthcare benefits. In another example, an arm/element can be made with square cross-section. The corner/edge of the square element helps to rub neighbouring teeth surface better, which is similar in getting triangular, pentagonal, hexagonal or other polygonal cross-sectioned elements. In addition, the core of those elements may be hollow so that they too can be reduced in cross sectional size when squeezed and helps in penetrating narrow inter-proximal gaps. It must be understood that those arms are not compulsory to be made of the same and each of those element does not have to be uniform in its cross sectional profile along its longitudinal direction. In other words, an element may have its some portion square and some portion in round, or a mixture of those patterns. The shape following twisted bar (e.g., square, triangle or other shapes) or spirally twisted can also be employed to build an element for an oral healthcare device as well. The derived benefits of better scouring and massaging are expected.

More than just altering a single element, the arrangement of those elements in an oral healthcare device facilities certain functions too. For an example, a device (9) with oval cross-sectional arms (3) and twelve such arms (3) makes rubbing more comfortable while less and/or thinner element (3) helps to engage food particles/fibres easier and scrape off plaques. Unlike usually uniformed

distribution of arms (3) around lateral principle axes (e.g., 60° an arm for 6 arms (3) around uniformly distributed around the circumference of 360°), a biased circumferential distribution of arms (3) may accommodate a device (9) with both wider and thinner arms within a device. The optimum combination of the number of element (3) cross-sectional area of an element (3), circumference arm distribution, size of the oral healthcare device (9) and other parameters helps to ensure the best suitability for many types of usage. For an example, an oral healthcare device (9) with only two bouncing wires/strips (3) is very suitable for insertion and drawing food debris out of traps. On the other hand, more elements (3) formed oral healthcare device (9) is better for gum massaging. Normally, the length of the oral healthcare device (9) is preferred to be comparable or slightly longer than a molar tooth's width, e. g., the length between 3~25mm. For an adult, the typical length can be 6~18mm for the device (9) will be more desirable.

An individual member of wires/strips (3) can be made from many materials such as metal, plastic, rubber, urethanes, certain polymers or other resilient material, the like. Preferably, those materials are appropriate for wet, hygienic and durable oral healthcare applications, such as stainless steel, nylon, polyurethane, etc.

Other than single type of material, an individual member of the wire/strip (3) can be made from compound structure/s or material/s to enhance its performance. For an example, an individual wire (3) can have a thin steel wire interior as a strong core with certain polymer surrounding it to form a filament (3) with slightly increased diameter/cross section/diameter. The interior of an arm (3, 39) can be hollow like a tube too. Besides, this filament (3) can be coated with TEFLON for better gliding and comfort with reduced friction. Further, the coating material or the material in contact with mouth made of TEFLON will generate battery effect in the normally acid environment in a mouth and further enhance the cleaning capability. Other materials, for various purposes, can be used to construct part of whole of the oral healthcare device

(9) to provide further benefits, such as for comfort, visual/sensory attractiveness, etc. by using minted or other coloured, flavoured plastics, coatings, etc.

Those resilient individual wires/strips (3) are not necessarily always to take smooth surface or uniform cross-section. To help in certain situations, an individual element (3) of an oral healthcare device (9) can be made with roughened surface, waving surface, rubber-sleeved, either partially or completely, front narrow and back thick cross-section, or changing profiles along the element's own longitudinal axis, etc. For an example, every element (3) in the oral healthcare device (9) can have part of its body sleeved with rubber with roughened surface so that those elements (3) can rub the teeth and gum better. An example of a currently available product, MicroPulse bristles in Oral-B Pulsar toothbrush is equipped such partially rubber-sleeved bristles/spikes which aim to clean inter-proximal regions, similar to a toothpick's function.

According to yet another embodiment, an individual wire/strip (3) of the oral healthcare device (9) can take the form non-straight connection linking front (1) and back ends (5) (see figure 6). For an example, an individual element (3) of the oral healthcare device (9) can connect two ends (1, 5) in a helical curvature (12), wavy curvature (10), meshed structure (8), etc. with or without a core (31) support. Those specific curvatures (8, 10, 12), such as spiral type (12), are desirable to assist insertion, especially accompanied with rotation.

Referring to figure 7, this laterally flexible (expandable & reducible) oral healthcare device (15, 17, 19, 21) can take many shapes as variations to perform similar functions. For an example, the top/side view of an oral healthcare device (9) may looks like a rhombus (15), a triangle (17), an egg-shaped (19), a substantially rectangle (21), etc. The desired shapes are however, preferred to incorporate narrow tip (1) for insertion, an back end (5) clustering all arms, and a base (6) for fitting into a small handle (7) where the

back end and base may be integrated as one. The profile or size of such oral healthcare devices (15, 17, 19, 21) is not necessarily to be similar because it much depends on applications. For an example, a small self-adaptive oral healthcare device (9) with long handle (7) can be used for the cleaning of a tooth cavity or root canal after dentist's drilling. Adding some front extension/s (23) to an oral healthcare device (9) (see figure 8) can help in guiding the insertion (25) between teeth and gum. The small extension (23) may be in the form of some bristles, resilient pricks, spiral threads, an array of conical flanges, a sphere, or a solid tip etc. to aid cleaning, massaging, or entering narrow inter-proximal regions, etc. Though many shapes are possible to form this laterally self-adaptive oral healthcare device (9), the front end (1) of this type of oral healthcare device (9) is preferred to take an acute angle ($<90^{o}$) during insertion. This is because an acute angle (viewed from the side or top) helps the oral healthcare device's (9) penetration while other factors, such as the surface roughness, rotational speed, etc. of the oral healthcare device (9) play other important roles too.

Other than built by a number of resilient filaments (3), the oral healthcare device also can take the structure of a continuous skin or membrane (29) formed body (30) (see figure 9). The interior of such oral healthcare device (30) can be filled with certain liquid, jelly, gas or their mixture to build a resilient body. For an example, the interior of such laterally self-adaptable device (30) can be filled with gel type medical treatment material/mixture and release gel through its porous skin when the oral healthcare device (30) is squeezed by neighbouring teeth and gum. The contour of the self-adaptable device (30) can be sustained by a resilient material as a shell itself, such as rubber, plastic (e.g., modified urethanes, modified ABS, silicone, polymer, and polypropylenes, etc.), etc. Other than gel/jelly, gas-liquid mixture, compressed air or other materials can also be used to fill the interior provided that the self-adaptable oral healthcare device (30) is hygienic and suitable for oral healthcare applications. A porous membrane (29), which enables gentle and gradual release of medicaments, is especially suitable for massaging and treating

infected/swelling gum. It is understood that this oral healthcare device (30) is sometimes not required to be supported by a core (31) at all times, the resilient profile may just be sustained by a thin layer of rubber shell as stated above. However, this balloon-type oral healthcare device (30) is preferred to have a supporting core (31) along the oral healthcare device's central axis (11) for better insertion and extraction (27). The effective length of this core (31), meaning the distance between the front end (1) and the back end (5), is possible made to be adjustable so that the contour of this oral healthcare device (30) can be adjusted to suit some required applications. At most times, the front tip (1) is desired to have a narrowly pointed guide (32), such as a cone (32) for the balloon type of oral healthcare device (30) to have better penetration. The self-adaptive olive stone/rugby ball like profile or an American football shape can also have its external surface (e.g., the membrane (29)) roughened, textured, multiple small-pricks covered, nipple/small bumps covered, or other patterns of surface so that each of these surfaces or their combinations can help to scour, massage gum/teeth, or release medicament better.

Referring to figure 10, elements/arms (39) or core support (31) which form the laterally self-adaptable device (34) can be in the form of a tube. Those tubes enables to delivering fluids (e.g., water, treatment fluids) or solids (e.g., smoke) to inter-proximal regions. Moreover, tube-type arms (39) can be squeezed thus give more rooms for lateral transformations or adaptations.

Vibration is also one of the useful forms of movement for cleaning and massaging, either below, substantially equal or above the sonic frequencies (20~20,000 Hertz). If the oral healthcare device vibrates at an ultrasonic frequency to produce a cavitation effect with its proper structure, it can further enhance cleaning effects. However, it is highly recommended that an ultrasonic vibration or cavitation oral healthcare device is operated by a trained personal, such as a professional dentists or periodontists because a device/article vibrating at ultrasonic frequencies can potentially cause severe

damage to teeth and surrounding tissues if not properly used. With proper usage, ultrasonic vibration or cavitation can help to remove stubborn tartar or calculus in the inter-proximal regions where it is difficult to reach for a normal toothbrush. Such sonic technology is presented in US 3,335,443 and US 3,809,977. Low sonic vibration may also help as shown in US 3,535,726 and US 3,676,218. Moreover, low audio frequency range (200~500 Hertz) vibration of the oral healthcare device may produce mild cavitation and the technique is readily disclosed in US 5,309,590 and US 5,378,153. The vibration technique adopted by preferred embodiments is not limited to any type of previously disclosed oral healthcare device, even with load sensor and alarm features included, such as those shown in US 5,815,872 and US 5,784,742. A sensor/s integrated device helps to exert appropriate rubbing on teeth and gum automatically.

Sonic energy generator (US 4,787,847), whether it is coupled to a load sensor for monitoring generator workloads, can be incorporated for improved inter-proximal cleaning. The sonic energy is provided by piezoelectric multi-morph transducer causing vibration at resonant frequency or its multiple thereof. These frequencies are in the low-audio range to provide for the disruption, removal of plaque, interrupting and limiting the process of plaque maturation as well as its development. In this frequency range, an applicator member such as the oral healthcare device or its certain elements is fixed to a free end of the transducer and extends to scrub exposed inter-proximal surfaces. Mild cavitation is caused within the sub-gingival fluids and further promotes the removal of adherent plaque colonies, demobilise motile bacteria without harming tissues. For an example, the subsonic vibration frequency can be 20~400 Hertz (the optimum at around 350 Hertz) for the coupled oral healthcare device and the front tip's velocity can be at least 2.0 meter per second while the amplitude ranges from 0.2 mm to 5 mm. It is found that the exerted acoustic pressure of at least 1.5kPa on the oral healthcare device is very effective for removing dental plaque. When a self-adaptable oral healthcare device rotates and vibrates with sonic energy (e.g., amplitude

around 2.5 mm, frequency around 250 Hertz, instantaneous velocity at an arm 1.5~3.9 metre/sec or less), its arms or membrane will scour teeth and massage gum so that plaque is dislodged easier.

There are many advantages to enable the oral healthcare device to swivel with respect to its base (6), regardless its rotation around the axis (11) (see figure 11). This swinging allowance (41) of the oral healthcare device (9) in a three dimensional space makes it easy for manoeuvring in a complex oral interior. The swinging movement is preferred accompanied by some stiffness of the support to the back end (5) so that the device (9) will be restored to its original position when an external bending force is removed. The swinging mechanism can be achieved in many forms. For an example, the oral healthcare device (9) can be installed to a handle (7) similar to that used in "Oral-B Compact Interdental Brush" (US 5,309,596; US 5,377,377, US D 360,077). Another simple alternative is just to fix the oral healthcare device (9) to a resilient stainless steel wire/rod held to a base (6) or a handle (7). The oral healthcare device (9) can be swung in a sundry of directions (see figure 11) in a controlled manner too, including both lateral and longitudinal directions, arced oscillation about the axis (11), or/and circular precession about the axis (11). With the help of its flexible base (6), via a resilient wire connection, electrically/microprocessor regulated swinging mechanism, or other techniques, this oral healthcare device (9) is able to preset and adjust its orientation to diverse positions and user conditions when it is in oral cleaning, massaging, or idle situations, etc.

According to yet another form of the preferred embodiments, the oral healthcare device (33) has a core supporting shaft (31) along its axis (11) (see figure 12). One end of the core (31) is preferred to be joined with the tip (1) of individual wires/strips/arms (3) and made smooth for better gliding through inter-proximal regions. The other end (35) is either incorporated together with a supporting base (6) or made as a slider. With the core support (31), this oral healthcare device (33) is allowed expand or contract laterally with respect to its

central pillar support (31). Moreover, this jointed-end at the slider (35) side can be permitted to glide/move (38) along the core (31) within a certain range. This is to say that the back ends of those wires/strips (3) can be fused to the slider (35) together to move along the supporting core (31). The slider (35) with a hole for fitting the core support (31) carries out similar functions as a crux (lower annular nest) of an umbrella which holds/hubs ends of bones/ribs of an umbrella to open or close the umbrella. The idle portion (37) can be made either smooth or threaded for setting the effective lengths. The effective length also means distance between the front end (1) and back end (35) of the oral healthcare device (33). The slider (35), in turn, can be made with a smooth hole or an internally threaded hole for the matching with the shaft (31). The gliding movement of the slider (35) can be performed by other means, such as magnet's repulsion between slider (35) and the base (6). It is also permissible to put up a resilient means (e.g., a helical spring) in the idle portion (37) between slider (35) and base (6) to set certain preloaded compression force for the oral healthcare device (33) by adjusting slider's (35) position so that the lateral expansion/contraction force can be further regulated for more effective oral healthcare. An alternative for reducing effective distance is to pull the entire core (31) or front end (1) towards the handle (7) or base (6). When allowable effective distance between the front (1) and back ends (35) is subtracted by removing part of the core length, those resilient means (3) will increase their curvature and the oral healthcare device (33) expands laterally as a result.

Expanded oral healthcare device (9) during insertion or idle mode is not necessarily the only form. As an alternative, an oral healthcare device (40) can have its arms (3) or skin (29) closely attached (28) to the axis (11) or core support (31) when it is idle or during insertion into inter-proximal regions (see figure 13). A slider (35) can be incorporated that moves along the core (31) to inflate/expand or deflate/contract the oral healthcare device (40) laterally and increase/reduce effective length between front end (1) and back end (35). Here, the back end (35) is preferred to have all elements (3) fused to the slider

(35) and the oral healthcare device (40) can be inflated or expanded laterally by pulling the core (31) into (26) the handle (7). The oral healthcare device (40) having this mode of operation possesses the benefit of penetrating into inter-proximal regions easily with its narrower body and then expand with its arms/skins (3) contacting surroundings for cleaning and massaging, etc. This mode of execution requires either manual or automatic regulation of the expansion and contraction of this oral healthcare device (40). The change of lateral breadth can be either pushing/pulling of the slider (35) along the core (31) similar to the motion of opening an umbrella, or modifying the core's exposed length or effective distance, etc. There are in fact many other regulating methods which can achieve the similar objectives. For an example, one can twist the back end/slider (35) with respect to stationary front end (1) around X-axis (11) so that arms (3) or skin (29) of this device may be coiled/wrapped spirally around the central X-axis (11) thus the lateral breadth is regulated.

The oral healthcare device (9), either with or without a core support (31), is also preferably to be capable of being made rotatable (22) along its axis (11) to rub or scour around teeth's and gum' surfaces (see figure 14). Rotational movement of a device (9) has two types, which can either be passive or active. According to the passive type, the device (9) is made free to rotate at its base (6) around X-axis (11). When the device is inserted into or extracted out of an inter-proximal region, the frictional contact with neighbouring teeth and gum causes the device (9) to rotate (22). If multiple arms (3) of the device (9) are curved in spiral or threaded fashions (12, 14), the device (9) can have smoother rotational progressions. The active type of rotational movement (22) may be powered by an electric motor with rechargeable battery. In both passive and active types of rotational movements (22), the core support (31) may or may not rotate together with the arms (3). In some situations, arms (3) of the device (9) may be flexible (floppy or loose) which sags when they are idle and those arms (3) are (arguably) laterally expandable or contractible too. However, if a device (9) made with flexible arms (3) is rotated, it may still

perform certain scouring or massaging tasks although not in a perfected manner. If the back end (5) revolves around the core (31) while the front end (1) remains stationary with respect to the back end (5) of a device (9), arms (3) of the device (9) can also be made to expand or contract laterally (24) to achieve scouring and massaging objectives.

Throughout rotational movements (22) around the insertion axis (11), either continuously, intermittently, pulsing, or progressively with penetration, etc., the oral healthcare device (9) allows its arm (3) or body (9, etc) contact its surroundings properly. Clearly, whether the rotation (22) is exerted by one's hand, a mechanical spring, an electro-mechanical winder, or an electric motor does not change the fact that the rotational motion (22) helps for better engagement to food particles/fibres. Moreover, a suitable rotation speed control of the oral healthcare device (9) in combination with its proper spring/expanding force aids cleaning as well as massaging (penetration, extraction, etc.). An obvious implementation will be an electric motor driven solution which is a common place in many of today's electric toothbrushes with rotary brush heads, such as those mechanisms shown in US 2005/0,055,784, US 2004/0,060,136, US 2004/0,060,137, etc. The coupling connection from motor to the spinning oral healthcare device (9) can be done in many ways as well, such as a clutch connection, steel wire/rod linking to a motor's output, or those given in US 2004/0,226,121, US 2004/0,168,271, US 2004/0,154,113, etc. For an example, the connection mechanism used in the current widely available electric toothbrushes can steer the oral healthcare device (9, etc.) too, such as those in Colgate MOTION Electric Toothbrush, Oral-B AdvancePower 400 series, etc. When rotating (22) during the process of entering inter-proximal gap as insertion, the oral healthcare device (9) has the benefit of self-locating and easier gliding. The rotational movement (22) also enables rubbing neighbouring teeth for scrubbing off plaque and massaging gum better. Since the oral healthcare device (9) is self-adaptive to its surroundings, which in turn exerts suitable pressing/contacting force and can be adjusted, the revolving oral healthcare device (9) is therefore very suitable to capture and remove food

particles (e.g., using two elements (3)), as well as providing comfortable touch to gum. Both manual and power (e.g., electric) driven or other means can enable such revolving motion, if necessary, combined with other motions, such as vibration, swinging, etc. The rotational speed, either in continuous, pulsing or any other patterns, can be made adjustable depending on requirements.

Inter-changeability is another possible embodiment (see figure 15). The oral healthcare device (9) can be made detachable to facilitate sanitary process of the device (9), or simply replace it with a new piece. For an example, the oral healthcare device assembly (9) is held onto a base (6) with a notch/es and the base (6) is held to a handle (7) with a grip/s (43). Upon changing the oral healthcare device (9), the grip/s (43) is released by pulling the oral healthcare device (9) away from the handle (7). Afterwards, the replacement (9) is pressed back into the notch/socket (43) and held tightly. There are many methods or mechanism for changing heads (9) and these methods are commonplace in many applications, including those for changing electric toothbrush heads, such as techniques given in US 2005/0,011,025, US 2005/0,000,044, etc. For an example, the replacement mechanism used in Philips Oral Care products "Sonicare Elite" or "Sonicare Advance" brush heads can ready adopted for the current oral healthcare device (9) with some modifications.

More sophisticated functions can be realised when the core shaft (45) of the oral healthcare device (9) serves as a conduit for discharging liquid from its tip (1) or side (see figure 16). For an example, water may be supplied (48) and sprayed from the core's perforated surface (45) or its tip (1). While the oral healthcare device (9) is rubbing the inter-proximal regions, a water/fluid jet/stream from the oral healthcare device (9) further helps. The injected (48) water is not restricted to be continues. In fact, the stream of water/fluid from the oral healthcare device (9) can be pulsing, intermittent, or on demand via a manually/electrically/microprocessor controlled electric valve and pump system, which may include software or hardware control means, etc. An example of

conduit construction is given in IntelliClean system from Philips Sonicare in combination with Crest liquid toothpaste.

The conduit (45) in the oral healthcare device (9) can carry a single phase fluid, such as liquid toothpaste, gel-like fluid (jelly), etc., it can also be injected with two-phase mixture, such as air bubbles mixed with water, to clean, massage or treat the inter-proximal areas. The water bubble injection (48) can either be injected via the core shaft (45) alone or two separate channels/tubes for each fluid respectively. The bubble water from the oral healthcare device (9) is able to form tender waterfall-like bubble water streams. The optional moderate or accelerated speed of such fluids can either please and satisfies the skin with tender care, or blow off plaques or food debris under high pressure. Causing water or two-phase mixture to flow at special pulse forms hammer-like water stream and may tenderly beat teeth or gum for comfort.

To further assist cleaning or healing the teeth and gum, the conduit (45) in the oral healthcare device (9) can release certain medicament/s in a vapour, powder (tiny particles of solid such as smoke), liquid with supersaturated with oxygen, or in other forms. For an example, the commonly used "anti-bacterial mouthrinse" (typically containing Triclosan, PVMMA, etc.) can be injected (48) during mouth cleaning. To treat some oral diseases or remove odour, medicaments can be stored in a sachet/pouch packaged in a handle (7) and released either independently or mixed with water, air, or water/air mixture streams through the core (45), perforated & hollow filament (3), or porous membrane (29). The mixing procedure, which can either be done manually, automatically, or semi-automatically, is flexible for achieving the optimum mixing ratio for desired health effect.

Multiple oral healthcare devices can be chained (55), staggered, nested (53), grouped, or clustered together to form a useful tool for cleaning teeth/gum with orthodontic brackets and wires, implant abutments in place (see figure 17 & 18). Normally, there are gaps (51) available between neighbouring oral

healthcare device units which permit those self-adaptive bodies/device units to be squeezed laterally and elongated longitudinally to fill those gaps (51) when passing through narrow inter-proximal gaps.

Further the construction of multiple oral healthcare devices, a nested device (53) adds more functionality to the device (see figure 17). Preferably, the nested device (53) has fewer arms (3) at outer device unit and more arms (50) at the interior device unit. When this device (53) rotates or twisted within/inside/in the inter-proximal regions, the outer arms (3) facilitates to arrest food particles and inner arms (3a) provides massaging or rubbing comfort. The inner device made by a plural number of arms (50) may either be fixed at certain locations or allowed to move along the core support (31) freely. Multiple such devices at the interior of a device (53) are also an acceptable alternative.

An oral healthcare device (55) may comprise a plurality of device units (65, 67) chained with stiffness on the core (68) introduced (see figure 18), which is different from the one (see figure 19) with soft string (66) linkage. This device (55) is able to receive an insertion force from its back end (63) via a handle (7) or base (6) and transmit to the front end (57). Each device unit (65, 67) in this assembly possesses two ends, namely front (57, 61) and back (58, 63) ends. Each device unit (65, 67) has plurality of arms and is permitted expand/contract laterally on their own. This form of construction conforms better with inter-proximal regions if the narrow portion between two ends (58, 61) of neighbouring device units (65, 67) sits at the inter-proximal regions while two bouncing device units (65, 67) touches adjoining teeth with broader profile, especially accompanied by rotations. The core support (31) is favoured to allow adjacent device units (65, 67) be bent with respect to each other at permissible angles, such as $60^{o}$ or below.

As an alternative, a string (66) which connects those self-adaptive oral healthcare devices (9) can be made resilient material, such as elastomer types (see figure 19 & 20). When those oral healthcare devices (9) are forced to be

elongated, the string (66) can extend between front and back ends (1, 5) of each device (9) in the chain to allow those oral healthcare devices (9) taking thinner forms. Similar mechanism is also implemented to individual oral healthcare devices (9, etc.) of other embodiments. For an example, the movement of cleaning process by this type of string (66) aligned oral healthcare devices does not have to have bi-directional or reciprocal movement during cleaning, meaning insertion followed by extraction, or vice versa. It can take the movement of unidirectional or singular direction, as entering an inter-proximal gap from one side and then leave from the other side of the inter-proximal regions.

The application of such self-adaptive oral healthcare device is not limited to inter-proximal region only. If a self-adaptable oral healthcare device (9, etc) is made to suitable size, it can be inserted into other narrow places for other forms of oral healthcare too. For an example, a device (9) with long and thin support/handle can be used to clean root canals in endodontic treatment.

Various embodiments of the invention have been described. The descriptions are intended to be illustrative, not limitative. Thus, it will be apparent to one skilled in the art that certain modifications may be made to the invention as described without departing from the scope of the claims set out below.

Industrial Applicability

Some possible embodiments bring a product of a wire/strip (3) formed cluster (9) which expands laterally to construct an inter-proximal oral healthcare device (9). The mode of manufacturing and assembling much depend on the production volume, desired quality, feature and other factors. The device proposed can be used by both domestic users and medical practitioners, etc.

For an example, a durable oral healthcare device (9) as an embodiment may take stainless steel as its curved element (3) or core (31) for an oral healthcare

device (9). The stainless steel wire/strip (3) can also serve as the interior with other plastic moulded surrounding it (3) to change its external or surface property. The individual filament (3) can be coated with TEFLON, other materials, or their combinations, too. For replacement set, pre-sterilised moulded plastic oral healthcare device (9) is suitable.

The thickness or diameter for every individual wire/strip (3) of the oral healthcare device (9) can be a variable parameter to produce many types of self-adaptive oral healthcare devices (9) with various bouncing forces, termed as soft or hard oral healthcare devices (9). This can suits children, adults or patients with different needs. For an example, a soft and small oral healthcare device (9) is more suitable for a child while a harder and larger oral healthcare device (9) is proper for an adult.

In the form of a product, those oral healthcare devices (9) can be sold either alone or integrated with handles (7), either detachable or integrated. Furthermore, oral healthcare devices (9) with variation in the number of elements (wires/strips) (3) for each oral healthcare device (9) is another choice for product range variations since it will affect the ability of a oral healthcare device to capture food debris, contact force with teeth/gum, etc. A careful selection of the length and width for the oral healthcare device (9) in combination with other parameters can build a range of speciality products.

Claims

1. A device for oral healthcare having:
a front end for inserting into an inter-proximal region;
a back end for applying an insertion force;
a medial portion between the ends; and
elements of the medial portion that contact the inter-proximal region are aligned to a direction of insertion for guiding;
wherein the medial portion is able to expand or contract laterally when moving inside the inter-proximal region.

2. The device according to claim 1, wherein the medial portion have at least one laterally expandable or contractible fin.

3. The device according to claim 2, wherein the fin is formed by a sheet.

4. The device according to claim 2, wherein the fin is formed by a filament or strip.

5. The device according to claim 2, wherein there is a resilient shaft connected to the fin/s for supporting.

6. The device according to claim 5, wherein the resilient shaft is a tube.

7. The device according to claim 1, wherein the medial portion is able to expand or contract laterally by changing a distance between the ends.

8. The device according to claim 1 or 7, wherein the medial portion is resilient for expansion or contraction.

9. The device according to any one of the preceding claims, wherein medial portion is able to expand or contract by relative rotational movements between the ends around an insertion axis.

10. The device according to any one of the preceding claims, wherein at least one element is flexible.

11. The device according to any one of the claims 1 to 9, wherein at least one element is resilient.

12. The device according to claim 10 or 11, wherein the element is a tube.

13. The device according to claim 12, wherein the tube element has one or more openings at its front end, back end, on its lateral surfaces or in any of these combinations.

14. The device according to claim 10 or 11, wherein the element is braided with bristles or covered with other forms of small protrusions.

15. The device according to claim 10 or 11, wherein the element comprises a plurality of layers of materials.

16. The device according to claim 10 or 11, wherein the said elements are either uniformly or in an unsymmetrical manner distributed around the insertion axis.

17. The device according to claim 10 or 11, wherein the element is made of treated materials, such as minted, flavoured, medicated, quasi-medicated materials, or the like.

18. The device according to claim 10 or 11, wherein the element is either completely or partially sleeved with additional materials, such as rubber, polymer, biocompatible or biodegradable materials.

19. The device according to any one of claims 7 to 11, wherein the element is a membrane.

20. The device according to claim 19, wherein the internal space enclosed by the membrane is filled treatment materials, such as medicaments, soothing gel or the like.

21. The device according to claim 19, wherein the external surface of the membrane is textured, roughened, porous, scattered with nipples/bumps, covered with short spikes, covered with grooves, covered with spiral channels, covered with low flanges, covered with threads, covered with other undulating surfaces, or the like.

22. The device according to claim 19, wherein the membrane is resilient, inflated, or in combination of these.

23. The device according to any one of the preceding claims, wherein the device can be attached to or detached away from a handle.

24. The device according to any one of the preceding claims, wherein the device is integrated with a handle.

25. The device according to any one of the preceding claims, wherein the device has a core support along the insertion axis.

26. The device according to claim 25, wherein one end of the element is connected to a slider that can move along the core support.

27. The device according to claim 25 or 26, wherein the slider can be affixed to certain positions on the core support.

28. The device according to any one of the claims 25 to 26, wherein the slider can be rotated around the core support, moved along the core support, or in combination of both.

29. The device according to any one of the claims 25 to 28, wherein the core support is a tube perforated at the end or on its lateral surface for discharging fluids.

30. The device according to any one of the preceding claims, wherein the device is able to be rotated passively for contacting its surroundings.

31. The device according to any one of the preceding claims, wherein the device is able to be rotated actively by a driving mechanism.

32. The device according to claim 30 or 31, wherein the rotation can be controlled manually, automatically, or in combination of both.

33. The device according to any one of the preceding claims, wherein the device is able to vibrate.

34. The device according to claim 33, wherein the device is able to vibrate below sonic frequencies.

35. The device according to claim 33, wherein the device is able to vibrate above sonic frequencies.

36. The device according to claim 34, wherein the device is able to vibrate at low audio frequencies, such as between 20 to 400 Hz.

37. The device according to claim 36, wherein the device is able to vibrate at $350 \pm 25$ Hz.

38. The device according to any one of the claims 33 to 37, wherein the device is able to vibrate continuously, intermittently, or following a pre-determined pattern.

39. The device according to claim 33, wherein the arm of the device is able to vibrate with an amplitude of 2.5±2mm, frequency around 250±50Hz, instantaneous velocity at the element 1.5~3.9 metre/sec, or in combination of any of these.

40. The device according to any one of the preceding claims, wherein the device is able to release a material, such as gases, solids, semi-solids, fluids, or in a mixture of any of those.

41. The device according to claim 40, wherein the released material is a healthcare material, water, gel, anti-bacteria mouthrinse, medicaments, toothpaste, or the like.

42. The device according to any one of the preceding claims, wherein the device takes a contracted profile or an expanded profile when it is in the process of insertion or idle.

43. The device according to any one of the preceding claims, wherein the expanded profile takes forms of an olive stone, rhombus, triangle, rectangle, or the like.

44. The device according to claim 10 or 11, wherein at least a portion of the member's cross section is circular, oval, rectangular, square, hexagonal, twisted polygonal bar, or the like.

45. The device according to any one of the preceding claims, wherein the front end has an additional guiding means to ease insertion.

46. The device according to claim 45, wherein the guiding means has a portion of thread, fin, cone, sphere, oval, or any other shapes.

47. The device according to any one of the preceding claims, wherein the device is capable of swinging with respect to the supporting handle in various directions, passively, actively, or both.

48. The device according to claim 10, 11 or 19, the element is coated, such as by TEFLON, plastic, or other suitable coatings.

49. The device according to any one of the preceding claims, wherein the device is equipped with sensors for automation, such as load/force sensor, speed sensor, pressure sensor, proximity sensor,

displacement sensor, stress/strain sensor, noise sensor, vibration sensor, timer, or the like.

50. The device according to any one of the preceding claims, wherein the device is connected to a filled bag, sachet, or pouch for automated or manual discharging.

51. The device according to any one of the preceding claims, wherein the device is capable of being operated as corded using external power supply, cordless using internal power supply, or in combination of any of these.

52. The device according to claim 10, 11 or 19, wherein the element is made of medical polymers or biocompatible materials.

53. The device according to any one of the preceding claims, wherein the device has at least one device, termed as a device unit for the whole device assembly, nested inside another.

54. The device according to claim 53, wherein an external device unit is allowed to have relative movement with respect to its interior device unit, such as linear movement, rotation, expansion, or contraction, etc.

55. The device according to any one of the preceding claims, wherein the device comprises a plurality of device units mounted serially on the core support.

56. The device according to claim 10, 11 or 19, wherein the member is able to be replaced/repaired for repairing or changing.

57. The device according to any one of the preceding claims, wherein the device is able to be reused after a sterilisation or disinfection process, such as hot water boiling, medical alcohol cleaning, ultraviolet light exposure, dishwasher cleaning, microwave treatment, etc.

58. The device according any one of the preceding claims, wherein a plurality of such device units are connected serially by a flexible or resilient filament.

59. The device according to claim 58, wherein a frontal device unit is smaller than some other device units of the device assembly.

60. The device according to any one of the preceding claims, wherein a plurality of such device units are connected in parallel.

61. A method for oral healthcare using the device according to any one of the preceding claims.