Review Article

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The Use of Elastics in Orthodontics

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Abstract

The use of elastics in orthodontic treatment is not new, for ages orthodontists used different techniques to benefit from the unique physical properties of elastics. Keeping with the new industrial developments, manufacturers developed synthetic elastics with different configurations and superior properties. This review has been conducted to evaluate the available data regarding the different types of elastics used in orthodontics, their forces, benefits and drawbacks.

Keywords: Intra-Oral Elastics; Extra-Oral Elastics; Vertical Elastics; Intramaxillary Elastics; Intermaxillary Elastics.

Introduction

Elastomer is a general term that encompasses materials that after substantial deformation, rapidly return to their original dimensions [21, 36]. Elastics in dentistry are not a new development. One of the earliest applications of elastics was to extract teeth in patients with bleeding disorders (e.g. hemophilia, purpura), cardiac problems or mental deficiency. The practitioner simply placed a rubber band around the tooth to be extracted and waited for about 4-6 weeks for the surrounding bone and soft tissues of the tooth to be destroyed by the movement of the band. Currently this procedure is advocated in patients treated with bisphosphonates [29].

Elastics are mainly used in orthodontics as an active component to correct the different types of malocclusions, they are amorphous polymers made of polyurethane material that has the characteristics of rubber and plastic [2].

Elastics used in orthodontic treatment are either *natural* or *synthetic*. Naturally produced latex elastics are used in the Begg mechanics to provide intermaxillary traction and forces [8]. Synthetic elsastomeric materials in the form of chains find their greatest application with edgewise mechanics where they are used to move the teeth along the arch wire. This differs from the latex elastics which are changed by the patient daily [6].

History

A French man JMA Strange in 1841 claimed that he used a rubber attached to some hooks on the appliance surrounding the molars for retention. In 1843 – Dr. Edward Maynard was the first dentist to use gum elastics as a technique used to correct improper jaw alignment. An elastic material would be connected to wiring in the mouth to slowly move the jaw until it was in proper alignment. E.J. Tucker in 1850 elaborated Dr. Maynard's idea of using gum elastics to correct jaw alignment. Tucker took rubber tubing, and cut it into small bands that could comfortably fit into the mouth. In 1892 – Henry A. Baker was the first to combine many of the concepts used by previous dentists into one orthodontic treatment. Baker devised the method known as the "Baker anchorage." Baker anchorage combines the

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rubber tubing discovered by E.J. Tucker, with the wire crib. This technique eliminated the need to completely remove numerous teeth to help correct their alignment [5].

The latex elastics have become an integral part of orthodontics after Calvin S. Case discussed the use of intermaxillary elastics in 1893 at the Columbian dental congress but the credit goes to Henry A. Baker. Angle described the technique before the New York institute [24, 33]. In 1958 Fred Shudy recommended short class II elastics in association with a high pull anterior extra oral force in order to control vertical cases. Jarabak J in 1963 described the biomechanics of class II elastics for the first time. In 1965 Raymond Begg used class II elastics which were changed every 5 days.

Ricketts RM in 1970 originated the bioprogressive segmental light square wire technique advising the use of elastics in closing open bites. Roth R in 1972 recommended short class II elastics to help the curve of Spee leveling. In 1996 Micheal Langlade developed the clinical applications of elastic forces in different situations such as occlusal elastics, crossbite elastics, and proposing biomechanical comparisons in clinical uses [22].

The elastic bands are either natural or synthetic. Initially the elastic bands were made from natural rubber which is known to absorb water and its elasticity deteriorates quickly, later the early European explorers came to Central and South America, they saw the Incans playing with bouncing balls made of rubber. The rubber tree was called "*Cahuchu*", weeping wood. The drops of latex oozing from the bark of the tree made them think of big white tears this is known as "*Hevea brasiliensis*", this has been used by the ancient Incan and Mayan civilization. It is purified and mixed with gum, ammonia, antioxidants, and antiozone agents and then further processed for various uses [6,22,19].

Synthetic rubbers are chemical materials intended as substitutes for natural rubber. These were introduced in the 1960s ad have become an integral part of the orthodontic materials [19]. Synthetic rubbers are grouped into two classes: General-purpose and special purpose. The general purpose include the Styrene-butadiene rubber (SBR) which is made from petroleum, and the special purpose include butyl rubber, nitrile rubber, polysulphide rubbers, polyurethane rubbers and many more. These are better than natural and SB rubbers, as they have the ability to resist harmful elements including heat and cold [39].

Properties of Elastics

The natural or tree rubber is a hydrocarbon polymer of approximately 500 isoprene units. This structure varies in molecular weight depending on the plant, region and season. The most useful property of natural latex rubber is its resiliency. High quality latex more or less retains its resilience in water and under optimal conditions. The most significant limitation of natural latex is its enormous sensitivity to ozone layers and UV light. These elements weaken the latex polymer chain [39].

Most of the elastics currently used in orthodontics are made of polyurethane. The synthetic elastics are made of elastic polymer which has urethane linkage and are synthesized by extending polyester or a polyether glycol with a di-isocyanide. Polyurethane rubbers resist heat and withstand remarkable stress and pressure. However they tend to permanently distort, following long periods of time in the mouth. The major force decay occurs within the first 24 hours of their use in the mouth [19,39].

Synthetic polymers are very sensitive to the effects of free radical generating systems, notably, ozone and UV light, the exposure to these elements results in decrease in the flexibility and tensile strength of the polymer. Thus, manufacturers have added antioxidants and antiozone agents to overcome this [39].

Elastics are active components of orthodontic appliances. Due to their property of resiliency is used to generate continuous force to be applied on teeth to achieve tooth movement [39]. Their use combined with good patient cooperation allows the clinician to correct vertical, horizontal and transverse occlusal discrepancies.

Orthodontic Elastics are

Elastic bands; elastic chains (power chains); elastic ligatures (modules); elastic thread, tubes, sleeves and separators.

1. Elastic Bands

Elastic bands are manufactured by slicing rubber tubes of different lumen and wall thickness. The lumen of the band and its wall thickness determine the force value when stretched. Within each size of lumen existing there is three types of bands light, medium and heavy [19]. Classification is given in Table 1.

According to lumen size: The lumen of the elastic band is usually expressed in parts of an inch. For example; a 3/8 inches rubber band means that the lumen of the band in three parts of the eight parts of an inch [19].

Table 1: Classification of elastic bands used in orthodontics

1.	According to lumen size:
•	1/8”; 3/8; 5/8”; 3/16”; 1/4”; 5/16”; 1/2”
2.	According to force value
•	Light 2 - 3½ oz; Medium 4½ - 5 oz; Heavy 6 - 8 oz
(These vary according to manufacturer. Force is measured when elastics are stretched three times their diameter).	
3.	According to color
4.	According to use
a.	Extra oral (used for face mask)
b.	Intra oral
I.	Intramaxillary elastics (Class I elastics)
II.	Intermaxillary elastics (Class II, Class III, crossbite elastics and openbite elastics)

According to force value / tube thickness: Elastics are made of rubber tubing of different thickness, mainly three types: thin, medium and thick that determine whether the elastic is light, medium or heavy in terms of force value [19].

According to color: Different manufacturers use different color-coding and names for different elastic band size and force.

According to the use:

Extra-Oral Elastics: These type of elastic are used with the face mask for the correction of skeletal Class III malocclusion to aid in maxillary protrusion in cases where there is maxillary retrognathia (Class III type I) skeletal relationship [25]. Types and force used: ¼ elastics 16 or 32 oz (Figure 1).

Intra Oral Elastics:

Used intra orally and attached to bracket hooks, buccal tube hooks, arch wire with anterior loop, sliding hooks, Kobayashi ligature tie, sliding jig or temporary anchorage devices, these are divided into two:

• *Intramaxillary Elastics*

Class I Elastics or horizontal elastics placed anteroposterior in the same side of the same arch. Used for anterior segment retraction; space closure within an arch; extrusion; intrusion; tipping correction; rotation and midline shift correction. Could also be used with removable appliance to retract anterior segment here the elastic band is attached in the hook of the left and right to the upper canine and pass labial to the upper anterior teeth to push them backward (Figure 2, A).

• *Intermaxillary elastics:* Intra-oral elastics placed in both arches, classified into Class II and III:

Class II Elastics are intermaxillary elastics placed anteriorly in the maxillary arch and posteriorly in the mandibular arch. *Uses:* Skeletal and/or dental Class II malocclusion; anchorage reinforcement; backward movement of the upper incisors; mandibular arch advancement and bite opening Class II elastics can also be used to burn mandibular anchorage for the activation of mandibular closing loops [1]. In this case the force used is ¼ inch; 6 oz. worn for a continuous 72 hours, followed by night time only. The current literature suggests using light forces obtained with a 3/16-inch diameter [17, 9] Forces suggested were (1-2 [27, 26], 2.5 [30], 3.5 [34], and 4 oz [9].) with a mean of 2.6 oz.

Clinical Problems with Class II Elastics: should not be used with light wires that cannot control torque, because they may cause: Flaring of the mandibular anterior teeth; lingual tipping of the maxillary anterior teeth; mandibular molar extrusion; alteration of the occlusal plane and increase lower facial height. Class II elastics are to be avoided in cases with anterior open bite. There is a 20-25% decrease in the force applied for the 24 hour period, whereas most of the relaxation was shown to occur within the first 3-5 hours, after extension, regardless of size, manufacturer or force level of the elastic [15]. To minimize relaxation, patients may be instructed to change elastics twice daily (Figure 2, B).

Class III Elastics: They are intermaxillary elastics placed posteriorly on the maxillary arch and anteriorly in the mandibular arch. Indicated to correct Class II malocclusion; prevent advancement of the mandibular anterior teeth in a crowded non-extraction cases and deep bite cases with crowding. Indicated forces are 3/16 inch 4 oz., 6 oz. and 8 oz. elastics [16]. Using excessive forces with Class III elastics may cause periodontal problems, lingual tipping or extrusion of lower incisors using light *archwires and extrusion* of upper posterior teeth (Figure 2, C).

Open Bite Correction Elastics

Used for the correction of open bite up to 2 mm. They can be in the shape of a box, triangle, ‘M’ or ‘W’, ‘V’ and reverse ‘V’ shape plus any vertical configurations.

Box elastics: Have a box shape configuration and can be used in a variety of situations to promote tooth extrusion and improve intercuspation. Most commonly include upper lateral incisors and lower canines, upper canines and lower first premolars (Class II) or lower canine to upper premolars, lower lateral incisors to upper canines (Class III). Elastics prescribed are ¼ (4.5 -5 oz). Can also be applied to all bicuspids for their extrusion in lateral open bites, with 3/16 (4.5-6 oz) elastics (Fig. 3, A and B).

Triangular Elastics or V Shape Elastics: These elastics have a vertical component of extrusion. *Indications:* Increase over bite of cuspids by 0.5-1.5 mm. Extended from upper cuspid to lower cuspid and bicuspid.Can be worn to bring a tooth on the occlusal plane in a 'V' or reverse 'V' shape according to the clinical need (Figure 3, C and D). Triangular elastics are 1/8 (2.5 - 4.5 oz).

The 'M' or 'W' Elastics: These are used for extruding a group of teeth in order to establish a good intercuspation [3,1]. The configuration for Class II malocclusion is a 'W' shape with a tail. The configuration for Class III malocclusion is an 'M' shape with a tail. In case of a Class I malocclusion, the configuration is an M-1/2 shape (Figure 3, E and F). The force recommended is ¾ (2.5-4.5 oz).

Vertical Elastics: Used when there is difficulty in closing the open bite, whether anteriorly or posteriorly. Contraindicated in malocclusions that were originally characterized by deep bite. Have a tendency to narrow the transversal dimension (Figure 4 A).

Midline Elastics (Alexander): Used to correct small midline discrepancies. Forces used are 1/4"(6 oz). Applied from maxillary canine over midline diagonally to the contralateral canine. Can be used with Class II and Class III elastics (may cause a cant of occlusal plane). Worn full time except when eating (Figure 4 B).

Crossbite Elastics: Indicated in unilateral or bilateral cross bites, to expand and upright upper molars, which have tipped palatally. Two types: *Homolateral:* Applied to the buccal surface of one molar to the lingual surface of the opposing molar. Bands applied are 3/16" elastics 6 oz to be worn 24 hours per day. It is to be avoided in open bite cases [1]. *Contralateral:* Intermaxillary elastics placed on opposite sides of the two dental arches, e.g. from the left upper molar palatally to the right lower molar buccally (Figure 5 A and B). Useful in correcting posterior unilateral crossbite [22].

Elastic bands storage and dispensing: Elastics should be stored away from moist, heat and ozone or other free radical generating systems such as sunlight or ultra violet light that produce cracks, to avoid the loss of their properties. One of the manifestations of ozone on elastic bands is the reduced force value, which may be seen after a short period of time after manufacture. Therefore, manufacturers dispense elastics bands in sealable opaque pouches to prolong their shelf life. A new pouch of elastics should be dispensed and the ones with reputed manufacturing companies are more reliable in force delivery and force degradation in the oral environment. Manufacturers also follow a coding system to denote different elastics; this helps the patient to be more interested in the treatment and helps the staff in differentiating between different types of elastic bands and their uses [19,39]. For the ease of application by the patient a special key is dispensed to the patient (Fig. 6).

2. Elastic Chains (Power Chains)

After their introduction to the dental profession in the 1960s, they have become an integral part of fixed appliance orthodontic treatment [6]. Available in all colors, and in three configurations according to the length of the filament, these are closed, short and long filaments (Figure 7B). The configuration of the chain appears to affect the behavior of elastomeric chains [6, 4,40,10,37]. Generally the longer filament chains will deliver a lower initial force at the same extension and exhibit a greater rate of force decay under load than the closed loop chain.

Power chains are dispensed as long chains rolled in an easy to handle spool. These should not be used directly in mouth from spool, which results in its contamination with saliva [11]. They are also available in the form of small pieces of two or more modules with variable filament lengths to accommodate space closure in small segments [19].

Used to generate light continuous forces for [6,19]: Canine retraction; Diastema closure; rotational correction; extraction space closure; arch consolidation and selective shift of the midline (Figure 7 A and B).

Force delivery and force degradation

During the first day of loading in the mouth most chains lose 50-70% of their initial force, and at three weeks they retain only 30-40% of the original force [6,3,2]. It would also greatly depend on the manufacturer, storage conditions and age of the product. The prudent clinician should use a force gauge to determine the desired initial force [6].

Pre-Stretching Effects

Wong AK recommended chain pre-stretching up to one third of their original length to stress the molecular polymer chain [39]. Pre-stretching is expected to give more stable force and prevent rapid force decay.

100% pre-stretching of the chains original length 10 seconds before loading resulted in clinically insignificant improvement in force decay [38]. However the clinical value of pre-stretching is questionable [6, 20].

Environmental Effects

The alkaline pH of saliva has a slightly deleterious effect on the force decay of chains while the acidic pH of plaque exhibited substantial less force decay [13]. The immersion of power chains in alkaline glutaraldehyde solution for the purpose of disinfection does not affect their properties [18].

Intraorally elastics are exposed to enzymatic degradation, temperature relaxation and lipid absorption, which induce plasticizing effects. Therefore either clinicians should shorten the period between appointments or use steel ligatures while such mechanics are in place [6].

Elastic Chains vs. Coil Springs

Andrew L. Sonis in 1994 conducted a study on Ni-Ti coil springs and elastics he found the following: Ni-Ti coil springs showed the ability to produce constant force over longer periods of time. Ni-Ti coil springs produced nearly two times faster tooth movement than elastics. No patient cooperation needed and coil springs can stretch 500% more without permanent deformation [31].

3. Elastic Ligatures (Modules/'O' ring)

Modules are small ring elastics used to secure the arch wires to the orthodontic bracket. They are manufactured in two ways: injection molded and cut. The injection molded ligature is made by injection of liquefied elastomeric material into a mold and curing, whereas the cut ligature is sliced from previously processed elastomeric tubing [23]. They are available in different colors to keep patients motivated (Figure 8, A and B).

They have highly replaced steel ligatures because: They are easy to place and remove; save chair side time; patient comfort; less traumatic force; smooth borders that do not cause soft tissue irritation; long lasting arch wire seating (six weeks) [19].

Disadvantages: Absorb water and odors [19]; discoloration and staining with certain foods [14]; microbial accumulation [33]; poor control during torque and rotation correction; binding may occur with sliding mechanics [23, 7, 11, 28].

Elastic Ligatures vs. Wire Ligatures

Rotation and torque control require high force levels that elastic ligatures cannot provide [14]. Wire ligatures provide complete wire engagement into the bracket slot allowing complete prescription expression. Wire ligatures strength provide close wire placement in the slot, transferring elastic force from the arch wire to tooth. Elastic ligatures exhibit a greater number of micro-organisms in plaque than wire ligatures [33].

4. Elastic Thread and Tube (Sleeves)

Available as a round thread, with a smooth non-porous surface made of silk or nylon. It exerts light, continuous, long lasting, predictable force. Used to correct of rotations, traction of surgically exposed impacted teeth, minor space closure and numerous other intraoral applications with both fixed and removable appliances [19].

Elastic tubing is similar to thread but with a hollow core, which collapses when tied, resulting in tighter knots, that will not slip (Figure 9 A and B). Recently rectangular thread has been introduced whose knot does not loosen unlike round thread. Used initially to cover thin arch wires in an area where there is unerupted or missing teeth or in 2 x 4 cases. It is changed to coil spring when advance to stiff wires. Advantages: prevent irritation to the cheeks and lips.

5. Elastic Separators)

These are ring shaped elastics (Figure 10 A), which are placed around the contact points of teeth for a short period of time, no longer than two weeks [35], to slightly separate the teeth, to ease the placement of the molar bands. They can be placed using separator dental pliers or dental floss.

Elastic separators can slip into the gingival crevicular sulcus causing significant bone loss and tooth mobility [19,41] and because they are radiolucent it is wise to use bright colors to make a displaced elastic visible [28].

They can also be used to dislodge an impacted maxillary first molar by wedging the separator mesially to the first molar pushing it distally allowing it to erupt. But they are not recommended because they are difficult to place under the contact of the impacted molar and they have the potential to dislodge apically causing periodontal irritation [28].

For ease of placement separating pliers are used (Fig. 10 B).

Fig. 1: Heavy force elastic bands with face mask

Fig. 2: Class I (A), ClassII (B), Class III (C)

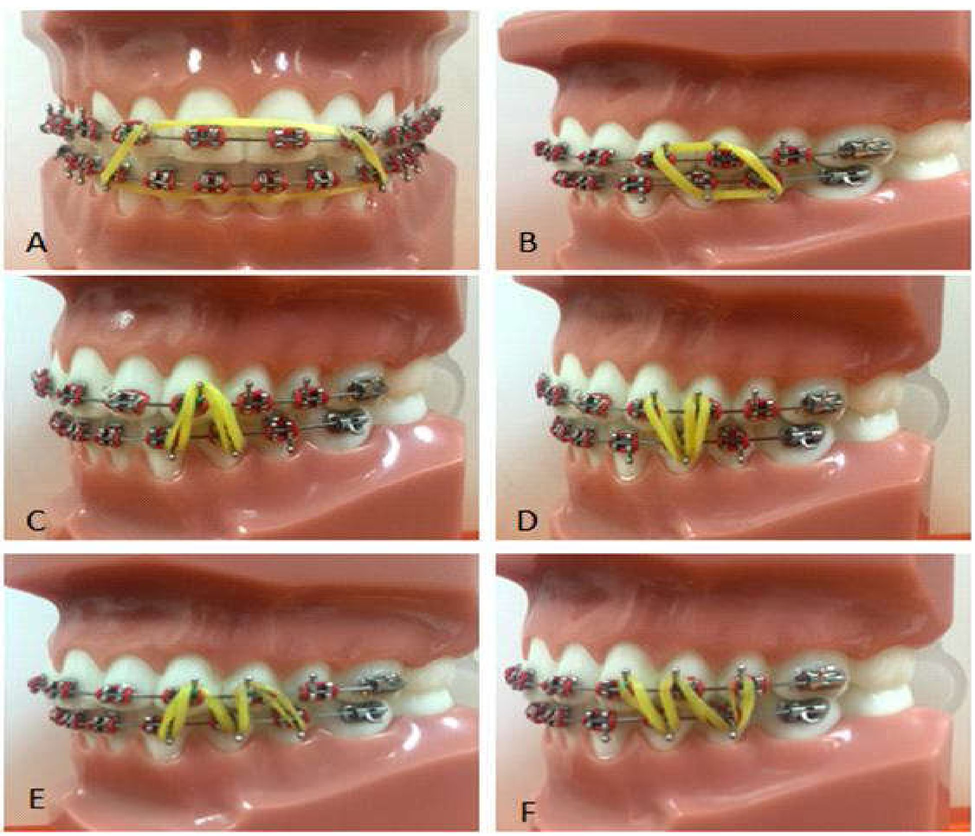

Fig. 3: Open bite correction elastics

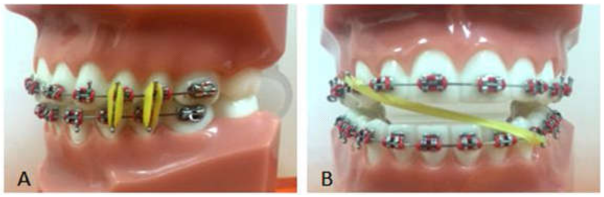

Fig. 4: Vertical Elastics (A) and midline elastics (B)

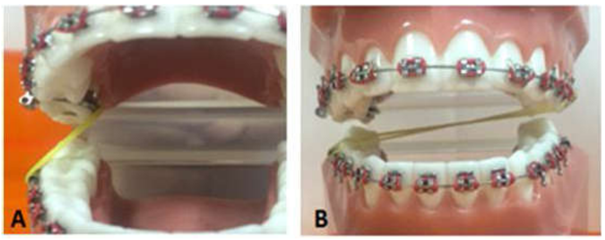

Fig. 5: Cross elastics (A) Homolateral, (B) Contraleteral

Fig. 6: Elastic hooks

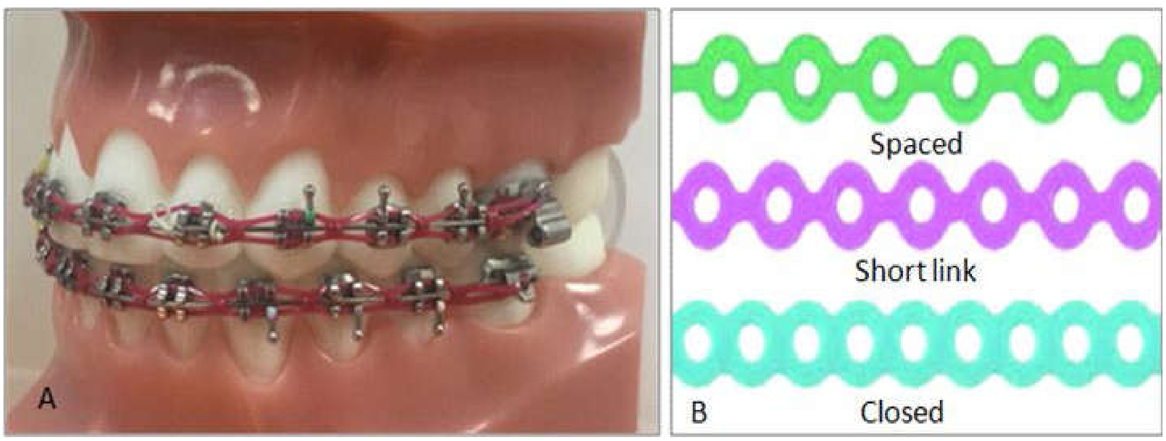

Fig. 7: Power chains in position (A), types of power chains (B)

Fig. 8: Modules (A), figure eight module (B)

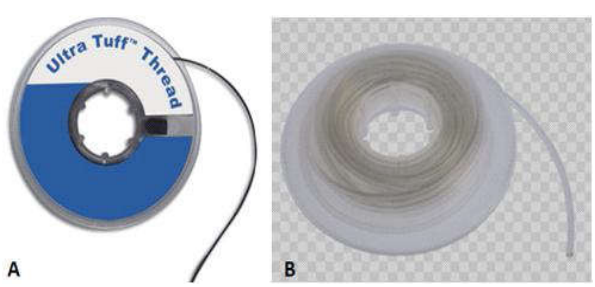

Fig. 9: Elastic thread and tube (sleeve)

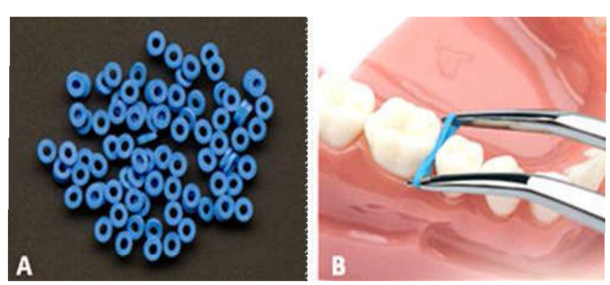

Fig. 10: Separators (A), placement of separator (B)

Natural Latex Drawbacks

Latex allergy: Is a medical term encompassing a range of allergic reactions to the proteins present in natural rubber latex [39]. It develops after repeated exposure to latex containing products. The amount of latex exposure needed to produce sensitization is unknown. Development of stomatitis with acute swellings and erythematous buccal lesions to the use of orthodontic elastics have been reported [19]. Orthodontic companies are marketing non-latex orthodontic elastics as the incidence of latex allergy continuous to rise and the use of non-latex orthodontic elastics increases, however, the mechanical properties of non-latex elastics cannot be assumed to be-and indeed are not-the same as those of latex elastics [17].

Cytotoxicity: Preservatives present in rubber bands may cause cytotoxicity to the gingival tissues [9]. Accelerating agents used in vulcanization and nitrosunstable amines present in rubber exposed to saliva are known to have the potential for nitrosamine formation [27].

Missing rubber bands and bone loss: Orthodontic rubber bands if not securely anchored to the orthodontic appliance hooks may slip into the gingival sulcus, causing pain, bone loss and tooth mobility. Thorough instructions in their placement and removal given to the patient can minimize such accidents. Since elastic bands are radiolucent it is wise to use bright colors to facilitate locating the misplaced rubber band [26, 30, 34].

Latex staining: Yellowish color change in orthodontic elastics compromise esthetics. Significant changes in color were found following exposure to different colored beverages and spices, color changes were most significant in clear modules, and spice mix had the most effect and cola beverage the least [15]. Lew K in 2009 found that coffee and tea beverages produced rapid staining within only 6 hours, chocolate beverages, red wine and tomato ketchup caused gradual staining, while cola drinks did not cause stains even after 72 hours [16].

Conclusion

- Detailed medical history including latex allergies should be taken.
- Avoid Class II elastics in high angle cases.
- Select the type of elastics and place of attachment carefully.
- If you are afraid to cause undesirable movement of the anchor unit, consider using temporary anchorage devices.
- If latex allergy developed during treatment, discontinue and use non latex elastics.
- Inform the patients about the clear elastics staining and you could use the colored ones.
- Advised to use light force in non-extraction cases and medium to heavy for extraction cases.

Recommendations

More studies are needed, as the literature is confusing regarding the force level of the elastic needed to generate the desired tooth movement.

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