■ *Review Article*

Elastics in orthodontics: a review

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Abstract

For some decades elastics have been a valuable adjunct of any orthodontic treatment .Synthetic elastomers overcome various limitations of natural rubber. The use of elastics in clinical practice is predicted on force extension values given by the manufacturer for different sizes of elastics. Elastics can be used in various configurations for correction of a particular malocclusion. To minimize the plaque retaining capacity of elastomeric chains and risk of demineralization fluorides releasing elastomeric ligatures have been introduced. The elastics however don't apply a continuous force over a interval of time due to the force degradation and are therefore inferior to Niti springs. There are increased incidences of latex allergies being reported in the literature and non latex products are available to overcome this limitation. It is very important for the orthodontist to educate the patient regarding the correct use of elastics as treatment results are dependent on patient cooperation. This article strives to summarize the currently available data on the various aspects of elastics including their properties, clinical usage and limitations.

Keywords: allergy, elastics, elastomerics, force degredation, flouride release

Introduction

Elastics and Elastomeric are routinely used as a active component of orthodontic therapy. Elastics have been a valuable adjunct of any orthodontic treatment for many years. There use combined with good patient cooperation provides the clinician with the ability to correct both Antero-posterior and vertical discrepancies. The latex elastics have become integral part of orthodontics after being first discussed by Calvin. S. case in 1893 at the Columbia dental congress but the credit goes to Henry A. Baker for the use of these elastics in clinical practice to exert a class II intermaxillary forces.[1]

Both natural rubber and synthetic elastomers are widely used in orthodontic therapy. Naturally produced latex elastics are used in the Begg technique to provide intermaxillary traction and intramaxillary forces.[2] Synthetic elastomeric 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. The links of chain fit firmly under the wings of an edgewise bracket so that chain elastomers also serve to replace metal as the ligating force that holds the arch wire to the teeth. Since they are so positively located on the brackets it is usual for the chains to remain in situ until replaced by the orthodontist at the next visit of the patient. This routine differs from that usually followed for latest elastics, which are changed by the patient every one or two days. The use of latex elastics in clinical practice is predicted on force extension values given by the manufactures for different sizes of elastics. The standard force index employed by suppliers indicates that at three times the original lumen size, elastics will exert the force stated on the package.[3]

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History of elastics and elastomerics

Early advocates of using natural latex rubber in orthodontics were Baker, Case and Angle. In 1846 E Baker in article on "the use of Indian rubber in regulating teeth" in New York dental recorder, he explained by cutting a narrow strip from thin sheet of Indian rubber and extending it to nearly its utmost capacity without breaking, fastened to the tooth to be regulated. 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. The appliance designed by John Tomes in 1848 for retraction of anterior teeth and it is activated by means of nut at the distal end. It is also believed that the use of elasticity developed by Schange in 1948. The appliance designed by Farrar treated by the rubber plains in 1876.

Calvin Case discussed the use of intermaxillary elastics at the Columbia Dental Congress. However Henry A Baker is credited with originating the use of intermaxillary elastics. Angle in1902 described the technique before the New York institute. Henry A Baker in 1893 introduced the use of intermaxillary elastics with the rubber bands, called as Baker anchorage.[4,5,6]

Synthetic Rubber: The important of rubber in war time became obvious during World War I.(1914-1918) Experiments in producing synthetic rubber were continued in 1920's chiefly by scientists in Germany and United states. Synthetic rubber polymers developed from petrochemicals in the 1920's have a weak molecular attraction consisting of primary and secondary bonds. Elastomeric chains were introduced to dental profession in the 1960's and have become integral part of many orthodontic practices.[3]

Natural versus synthetic

The most important limitation of natural rubber is the enormous sensitivity to the effects of ozone or sunlight, ultraviolet rays which generating free radicals breaks down the unsaturated double bonds at the molecular level this weakens the latex polymer chain. The swelling and staining is due to the filling of the voids of the matrix by fluids and bacterial debris. Synthetic polymers are also very sensitive to the effects of free radicals generating systems, notably, ozone and ultra violet light. The exposure to free radicals results in a decrease in the flexibility and tensile strength of the polymer. Manufacturers have added antioxidents and antiozonates retard these effects and extend the shelf life of elastomerics. Elastomeric materials swell less than the latex material. The most important of elastomeric materials is its ability to exert a useful force over a period.[3,7]

Analysis of elastic force

Force produced by elastics on a tooth or teeth depends on its magnitude. The stress produced depends on the site of application, distribution through the periodontal ligament and direction, length, diameter and contour of root, alveolar process, tooth rotation and health, age and above all the co-operation of the patient.[8]

CL I elastic traction is judiciously combined with strong anchor bend. Deliberate consideration of anchorage conservation is essential, because the resultant of the retractive and intrusive forces that lies distant to the maxillary molars will induce adverse movements or anchorage loss of the maxillary molars. Intermaxillary elastic force exerts pressure on the incisor in a vertical direction bringing them into supraocclusion or accentuating supraocclusion already present. Tilting of anchor teeth may also occur. The arch wire force on the lower molar tends to tip the crown distally and root mesially. The forward pull of the elastic force tends to counteract distal crown tipping and to augment mesial root tipping. If the anchor bent and elastic forces are appropriate the tooth will remain upright. The amount of light force exerted by the elastic is at an optimal level to tip the anterior crowns backward but a minimal level to move the lower molars forward bodily. Elastic force received by the molars and anteriors are equal and opposite, the resistance is not equal. So the crown tipping is relatively rapid and bodily movements are slow[9,10]. A continuous force can bring about rapid intrusive movement. Each anterior tooth will intrude by a force as light as 20 to 30 gms. The light force produces very short hyalinizations periods and the anterior teeth will be intruded quite rapidly. The tip back of the lower anchor molar in response to the anchorage bend can be controlled by CL II elastic force. When the elastic force is lower, the crown may tip back more and the root tip forward less. This is more often with 1 ½ to 2 ½ oz. (43 to 71 gms) elastics that usually sued in non extraction treatment. When the elastic force is greater, both crown and root mat tip. It may upright the molar but imparting little or no net distal movement. This is observed with 2 ½ to 3 ½ oz.(71-99 gms) CL II elastic in extraction cases. The different amounts of elastics forces, increasing with the rapid restoration rate of crown tipping and the slower rate of root movement can bring about tooth movement differentials suitable for problems ranging from CL II extraction cases to CL I non extraction cases.[2,4,11,12]

Force degradation

Latex elastics showed a greater amount of loss in strength than plastic elastomers when stretched over 21 day period. The synthetic elastomers stretched over a specific length and time exhibited a great loss in force. The force decay under constant force application to latex elastic, polymer chains and tied loops showed that the greatest amount of force decay occurred during the first three hours in water bath. The force remained relatively the same throughout the rest of the period. After an exhaustive review of the literature regarding elastomeric chain, it can be said that most marketed elastomeric chains generally loses 50% to 70% of their initial force during the first day of load application. At the end of three weeks they retained only 30 to 40% of original force.[13-20]

Classification of elastics

Elastics can be classified in many ways. According to the material, their availability, there uses and force.[7]

A. According to the material

Latex eastics

These are made up of natural rubber materials, obtained from plants, the chemical structure of natural rubber is 1, 4 polyisoprene.

Synthetic elastics

These are polyurethane rubber contains urethane linkage. This is synthesized by extending a polyester or a polyether glycol or polyhydrocarbon diol with a diisocynate

These are mainly used for elastic ligatures.

B. According to the availability

Different makers have different sizes and force, and the colour coding and the name is also different.

C. According to the uses

This also can be classified in 2 ways.

a.1 Intra oral

Intra oral elastics play major role in most forms of fixed appliance therapy. While there are some goals of elastic wear which transcend philosophical difference among treatment technique, there are others which apply only to specific types of mechanism the "vari-simplex discipline"; there are three basic applications of intra oral elastics. One is the alignment of maxillary dentition with the mandibular dentition to aid in the achievement of proper occlusion while sagittally correcting any centric relation/centric occlusion discrepancy. Cross bite, and /or midline discrepancy correction (transverse), is a second function. The third application is to help finalize the occlusion at the end of treatment (with emphasis on the vertical dimension).These includes the latex elastics, elastic chains, ligatures, etc.[20]

a.2 Extra oral

Extra oral elastics are used with extra oral mechanic systems. They can hook from the face bow to the cervical strap (cervical head gear), or from the face bow to the high pull strap (high pull head gear).These includes elastic modules, plastic chains and heavy elastics.

b.1 CL I elastics or horizontal elastics or intramaxillary elastics or intra-arch elastics

These extend within each arch. This is used for the space closure and to a certain extent; it can open the bite also. It is placed from the molar tube to the intramaxillary hook of the same side of the same arch and can be also called as intra arch elastics. The force recommended is 1 ½ to 2 ½ oz for non extraction cases and 2 to 4 oz. in extraction cases.[21]

b.2 CL II Elastics / intermaxillary elastics / interarch elastics.

This is extended from the lower teeth to upper molar teeth to upper cuspid which is placed from lower molar tube to the upper intermaxillary hook of the same side.They are primarily used to cause Antero-posterior tooth changes that is aid in obtaining CL I cuspid relationship from a CL II relationship. If the lower second molars are banded and include in the treatment mechano therapy, it is best to extend the elastic from the first molar to the cuspid tooth to avoid extrusion of the second molar and the creation of open bite anteriorly. If the lower second molar are banded it is best to extend the elastic from the second bicuspid to the upper cuspid (or even to lateral incisor for longer horizontal vector) if they are to be used for over two months of treatment. If the elastics are used for 2 to 6 weeks only, then one may extend them from the lower first molar to upper cuspid teeth. This treatment regimen minimizes the side effects from the use of elastics (extrusion of the lower posterior teeth and labial tipping of the lower anterior teeth, lowering of anterior occlusal plain and the creation of gummy smile). If any temporomandibular joint discomfort occurs elastic should be discontinued at least temporarily. The force recommended is 1 ½ to 2 ½ oz. in non extraction case and 2 to 4 in extraction cases.[22]

b.3 Class III elastics

Class III elastics are exact opposite of the class II's. They extended from upper molar to the lower cuspid. It is used in the treatment of CL III malocclusions. In some CL II cases also it is used to relieve edge relationship of the anteriors. It is attached from the maxillary molar to mandibular lateral incisor or canine. They promote extrusion of upper posterior teeth and upper anteriors, along with lingual tipping of the lower anteriors. The same principles discussed above apply for CL III elastics as well.[23]

b.4 Anterior elastics

It is used to improve the over bite relationship of incisor teeth. Open bite up to 2mm may be corrected with these elastics. They may extend from the lower lateral incisor to the upper laterals or central incisor teeth or from the lower cuspid to the upper laterals. It is used in conjunction with a plain arch wire for closing spaces between anterior teeth. It produces a reciprocal free tipping of anterior crowns, which closes the spaces. It is recommended only following lingual uprighting and over bite correction. It is placed between the intermaxillary hooks (Force-1 to 2oz.).[23]

b.5 Zigzag elastic

This is used for the rotation correction on the bicuspids. It is placed from bicuspid to cuspid and bicuspid to molar. This can cause undesirable molar movements also. This is indicated in extraction cases and where spacing is present. As the indicated in extraction cases and strength elastics are used. Force recommended is 2.5 oz.[24]

b.6 Cross bite elastics

This is indicated in unilateral and bilateral cross bites, to expand and upright lower molars which have tipped lingually. It is placed between the lingual aspect of the lingually placed molar and the buccal aspect of the opposing tooth.Force recommended is 5-7 ounce.

b. 7 Cross Palate Elastics

This is to correct the undesired expansion of the upper molars, during third stage. This is placed between the lingual aspects of the upper molars. Upper molar expansion during the 3rd stage is usually bilateral, the cross palate elastics is appropriate because the force it exerts in pulling one molar lingually is equal and opposite to the force it exerts in pulling the other lingually.

b.8 Diagonal elastics (midline elastics)

This is used for the midline corrections. It is placed one side upper intermaxillary hook to the other side lower intermaxillary hook. Force used is 1 ½ to 2 ½ ounces. It is also called as interior intermaxillary cross elastics.[23]

b.9 Open bite elastics

These are used for the correction of open bite. It can be carried out by a vertical elastic, triangular or box elastic. Vertical elastic runs between the upper and lower brackets of each tooth. [25]

b.10 Box elastics

Box elastics have a box shape configuration and can be used in variety of situations to promote tooth extrusion and improve intercuspation. Most commonly, they include the upper cuspid and lateral incisor to the lower bicuspid and cuspid and lateral incisors to the lower first bicuspid and cuspid(CL II vector) or to the lower cuspid and lateral incisors(CL III vector). All bicuspid teeth of one side can be extruded as well. These are used to correct the open bite or to decrease the anterior open bite. Elastics attached around the maxillary central and mandibular lateral brackets. Lateral boxes attached to maxillary laterals and cuspids and mandibular cuspids and bicuspids.Buccal boxes used to settle in the posterior occlusion or correct a more posterior openbite. Force used ¼" 6 oz or 3/16" 6 oz.[26]

b.11 Triangular elastics

Triangular elastics aid in the improvement of CL I cuspid intercuspation and increase the over bite relationship anteriorly by closing open bite in the range of 0.5 to 1.5 mm. They extended from upper cuspid to the lower cuspid and first bicuspid teeth. It is used for similar reasons of box elastics, but including only 3 teeth. Main concentration of force is on the tooth at the apex of the triangle. It is advised when a single tooth has to be brought to the occlusion. Elastics of 1/8" 3 ½ oz is used.[23]

b. 12 Vertical Elastics (spaghetti)

This is useful in whom there is difficulty in closing the bite, whether anteriorly or posteriorly. This type of elastic is contraindicated in malocclusions that were originally characterized by a deep bite. Force used is 3 ½ oz.[26]

b.13 M and W elastics

In an open bite or c1 III tendency some amount curve of spee should have been placed in the lower arch. Therefore some curve should be placed in the upper arch as well. The arch wire is sectioned distal to laterals or cuspids and up and down elastics ("M" with a tail) are worn. In class I case M or W without a tail is using. The upper and lower arch wire is sectioned in which the teeth to be extruded. In class II vector 'W' with a tail is giving.Force is ¾" 2 ounce.[23]

b.14 Lingual elastics

This can be used as a supplement or a counter balancing agent to buccal elastic force, there by increasing the efficiency of force distribution. It eliminates the tendency to procrastination that arises only alternative as a time consuming arch wire change, especially in III stage.

Lingualy tipped lower molars can be uprighted by the use of class II elastics attached between to lingual hook of the lower molar and intermaxillary hook of upper arch wire on the same side. Lingual elastics can be used as a substitute for buccal elastics like CL I and CL II elastics, provided the arch wire should be tied back to the cuspid bracket.[23]

b.15 Check elastics

When the arch wire tends to tip the molars distally, the molars direct the anterior portion of the wire gingivally providing anchorage in the vertical plane. The vertical anchorage can be reinforced by the single expedient of a pattern of intermaxillary elastic. One end of the elastic is hooked over the cinched distal end of the upper arch wire; both strands are hooked under the cinched distal end of the lower arch and the other end on the elastic hook mesial to the canine. Check elastics can provide a potent mechanism for overbite reduction, causing extrusion of maxillary and mandibular molars and counteracting the tendency of the anchor bends to tip the molars distally plus aiding incisor intrusion.[6]

b.16 Sling shot elastics (molar distalizing)

Two hook on buccal and lingual side of the molar to be incorporated in the acrylic plate to hold the elastic. The elastic is stretched at the mesial aspect of molar to distalize it.[12]

b.17 C1 II and C1 pull elastics

It is used for final setting of teeth. Usually ¾", 2 oz elastic is used. The elastic is used between each pair of teeth and hence on the central incisors on opposite sides of the midline.[23]

c. Other elastics

1. Asymmetrical elastics

They are usually CL II on one side and CL III on other side. They are used to correct dental asymmetries. If a significant dental midline deviation is present (2mm or more), anterior elastic from upper lateral to the lower contralateral lateral incisor should also be used.

2. Finishing elastics

Finishing elastics are used at the end of the treatment for final posterior settling. In CL II cases elastic begins on the maxillary cuspid and continuous to the mandibular first bicuspid, and in the same "upper and down" fashion it finishes at the ball hook of mandibular first molar band. In an open bite or CL III cases the elastic begins at the lower cuspid, continuous to the maxillary cuspid and finish at the maxillary molars.
The elastics are attached to the ball hooks on the brackets or to K-hooks (heavy ligature wires with an extension). They should preferably be worn full time(24 hours / day) for maximum effect, all though 12 hours a day wear may be indicated to their side effects. They should be changed once or a twice a day because the elastic fatigue rapidly (in contrast to elastomeric chains, which lasts 3 to 4 weeks).Force recommended ¾" or 2 oz.[23]

D. According to the force

1. High Pull
   Ranges from 1/8" (3.2mm) to 3/8" (9.53mm). It gives 71 gm force (2 ½ oz).
2. Medium Pull
   Ranges from 1/8" (3.2mm) 3/8" (9.53 mm) it gives 128gm or 4 ½ oz force.
3. Heavy pull
   Ranges from1/8"(3.2mm) 3/8"(9.53 mm) It gives 184gm or 6 1/2oz force.

Pre stretching of elastics

J. Young and J. L. Sandrik[20] suggested in 1979 that the chains should be pre-stretched by manufacturers or operator, which would decrease the force loss of the elastic polymer. Allen. K. Wong[7] suggested in 1976 that the elastomeric materials need to pr-stretched 1/3rd of their length to pre stress the molecular polymer chain. This procedure will increase the length of a material. If the material is over stretched a slow set will occur but will go back to original state in time. If the material is over stretched to near breaking point, over and over again permanent plastic deformation will occur. These means that the initial force may come to an effect during an pre stretched process. So when it is in use it will give more stable force.

Fluoride release from orthodontic elastic chain

Plaque accumulation around the fixed orthodontic appliance will cause dental and periodontal decease. Decalcification can be avoided by mechanical removal of plaque or by topical fluoride application or with a mechanical sealant layer.Controlled fluoride release device (CFRD) have been in use since 1980's. in such device a co-polymer membrane allows a reservoir of fluoride ions to migrate into oral environment rate[27].The permanent study was designed to a stannous fluoride release from a fluoride impregnated elastic power chain.The delivery of stannous fluoride by means of power chain would presumably reduce count and inhibit demineralization.(An average of 0.025mg of fluoride is necessary for reminerilization).But this protection is only temporary and of a continued exposure needs, the elastic should be replaced at weekly intervals. The force degradation property will be higher with the fluorinated elastic chain.[28,29]

Elastic ligatures vs wire ligatures

Elastic ligature may be a substitute for the wire ligatures in most situations.Elastic ligatures will give an easy work to the doctor and since no sharp ends it will be more acceptable by the patient.

In rotation control, higher force levels than elastomeric materials is required. With double brackets in rotation cases the partial engagement of the arch wire will be difficult with elastic ligature, so in three cases wire ligature are advised. When the sliding of a bracket on the arch wire is needed, it is advisable to use elastic ligature because of its smoothness. The strength and inflexibility of wire ligatures may also provide may also ligation. The relatively low strength of the elastic ligature is its major disadvantage. Ligature wire can transfer elastic force from arch wire to tooth and for holding the engagement of the arch wire in the bracket.

Coil springs vs elastics

To overcome the drawbacks of elastomeric material, Andrew L. Souis in 1994 conducted a study NiTi coil springs and elastics. He wanted to overcome the initial force decay of elastics and to use a material which provides, Optional tooth moving forces that elicit the desire effects.

1) Comfort and hygiene for the patient.

2) Minimal operator manipulation and chair time.

3) Minimal patient co-operation.

4) Economical.

This study shows the following:-

1.NiTi coil springs have been shown to produce a constant force over varying length with no decay. 2.NiTi coil spring produced nearly twice rapid a rate of tooth movement as conventional elastics. 3. No patient co-operation needed. 4.Coil springs can stretch as much as 500% without permanent deformation. The force delivered is 90 to 100gm.[30-34]

Elastic errors

Latex allergy: allergies to the latex proteins are increasing which has implication for dental practitioners because latex is ubiquitous in dental environment. Only 3 reports have been cited in the literature relating latex allergies to orthodontic treatment. 2 of these studies related the allergic reactions to use of latex gloves, and 3rd report related to the development of stomatitis with acute swellings and erythematous buccal lesions to the use of orthodontic elastics. Most documented allergic reactions to latex products have identified the residual rubber protein has the antigen. Reactions to latex carry with them a wide range of risk, and systemic reactions- in the extreme anaphylactic shock. Cutaneous exposure of individual sensitive to latex frequently causes contact dermatitis, where as either mucosal or potential contact – has with the use of orthodontic elastics- is more likely to induce a rapid systemic reaction such as anaphylactic shock. As the incidence of latex allergic reactions increases, the use of non elastic products within the orthodontic specialty as well as assessment of material properties of non latex elastics, will become increasingly important clinically.[35-39]

Instruction for wearing elastics

Louis Talmouis et al (1995)[40] has designed an instruction form for patients to understand instructions and demonstrate proper placement of elastics. The elastic configuration is hand-drawn on the form as the patient would be seen in the mirror.

Conclusion

Elastics are one of the most versatile material available to the orthodontist .Its an invaluable tool of the orthodontist armamentarium. An orthodontist who does not exploit these materials to the fullest is not doing justice to the patient. As a matter of fact it is all but impossible to practice in this branch of dentistry without this material.

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