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Elastics in Orthodontics

A project submitted to

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Certification of the Supervisor

I certify that this project entitled **" Elastics in Orthodontics"** was prepared by the fifth-year student under my supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

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Date:

Dedication

To the kindest and most beautiful hearts in my life (my mother and my father) … who gave me all the support and care in my life and they dedicate all their time for me and all the knowledge and passion they gave me to be the person who I am. To my supported siblings (my sisters) who encouraged me all the times .To my all (saifi) who gave me all support love and confidence thanx for having you next to me.

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Introduction

Elastomer is a general term that encompasses materials that after substantial deformation, rapidly return to their original dimensions. Elastic it is defined as the ability of a substance to return to its original length or shape after being stretched **(Asbell,1990).**

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 **(Behrents,2014).**

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 **(Asbell,1990)**

Both natural rubber and synthetic elastomers are widely used in orthodontictherapy. Naturally produced latex elastics are used in the Begg technique **(Begg and Kessling, 1977)**,*While* Synthetic elastomeric materials in the form of chains find their greatest application with edgewise mechanics **(Baty, 1994)**.

Orthodontic elastics are widely used in orthodontic practice with the purpose of helping orthodontic treatment,. As they are widely used materials in the orthodontic clinic, one must be concerned about the cytotoxicity of elastics, particularly the intraoral type that comes into intimate contact with the mucosa **(Wakelin and White , 1999).** Amongst the allergic reactions caused by orthodontic elastics, swelling and stomatitis, erythematous oral lesions, respiratory reactions, Because latex allergy is prevalent among many patients , so the need for non-latex alternatives is increasing **(Santos *et al*., 2012).**

- **Aims of the study**

This review aimed to:

Identify and recognize the different types of elastics that used in orthodontics, their classifications, benefits and side effects.

Chapter one: Review of literature

1.1 History of elastics and Elastomeric

A French man 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 **(Singh *et al*,2012).**

In 1893, Calvin discussed the use of intermaxillary elastics at the Columbia Dental Congress and certainly Edward Angle described the technique before the New York Institute of Stomatology in 1902 **(Barrie and Spence, 1973).** The introduction of elastomeric ligatures in the 1970s is also another milestone in orthodontics which largely replaced steel ligatures these are quicker and easier to place, and they can be used in chains to close spaces within the arch or prevent spaces from opening **(Baty, 1994).**

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 rubber tubing discovered by Tucker, with the wire crib. This technique eliminated the need to completely remove numerous teeth to help correct their alignment **(Asbell,1990).**

Henry Ricketts 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, crossbite elastics, and proposing biomechanical comparisons in clinical uses **(Langelade,2000)** .

1.2 Natural Rubber

When the early European explorers came to Central and South America, they saw the Indians playing with bouncing balls made of rubber. The South American Indians called the rubber tree cahuchu, i.e., weeping wood. The drops of latex oozing from the bark made them think of big white tears. In 1770, the English chemist Joseph Priestley discovered that the materials could be used as an eraser to rub out pencil marks. from this use we get the name rubber. Chemical analysis shows that about 30–35% of latex consists of pure rubber, while water makes up another 60–65%, the remainder consists of small amounts of other materials such as resins, proteins, sugar, and mineral matter.

Latex spoils easily and must therefore be processed into crude rubber as soon as possible after it has been tapped. This is done by separating the natural rubber in the latex from water and other materials. About 99% of all natural rubber comes from the latex of Hevea brasiliensis. In laymen terms, we call it the rubber tree. In 1860, another Englishman, Greville Williams, heated some rubber and obtained a colorless liquid that he called isoprene. Natural rubber has many unsaturated carbon atoms. Oxygen atoms from the air gradually attach themselves to these carbon atoms. This breaks down the rubber polymers so that the rubber becomes brittle or soft and loses elasticity.

The addition of antioxidants during compounding prevents this action. Scientists have not discovered all the answers to the chemistry of rubber. In many other ways, the chemistry of natural rubber remains a mystery **(Bishara and Anderson,1970; Brantley ,1979**).

1.3 Synthetic Rubber

Synthetic rubber polymers developed from petrochemicals in the 1920s have a weak molecular attraction consisting of primary and secondary bonds. Elastomeric chains were introduced to the dental profession and become an integral part of orthodontic practice. They are used to generate light continuous forces. They are inexpensive and relatively hygienic, can be easily applied, and require no patient cooperation. There have been numerous advances in the manufacturing process, which have led to a significant importance in their properties; with this there has been a greater application of these elastics in clinics in a variety of uses. Rubber-like materials that are made from chemicals were called synthetic rubbers because they were intended as substitutes for natural rubber. Chemists use the word “elastomer” for any substance, including rubber, which stretches easily to several times its length, and returns to its original shape. Synthetic rubbers have two classes:-

1- General-purpose Synthetic Rubbers: The most important one is styrene-butadiene rubber (SBR).

2-Special-purpose Synthetic Rubbers: Contact with petrol, oils, sunlight, and air harms natural rubber. Special-purpose synthetic rubbers resist these “enemies” better than natural rubber or SBR do. Also some of these special-purpose rubbers have greater resistance to heat and cold.

Most of the elastics currently used in orthodontics are made up of polyurethane. Polyurethane rubbers resist heat and withstand remarkable stresses and pressures. Polyurethane foams are dense to light. They have excellent strength and resistance to abrasion when compared with natural rubber. They tend to permanently distort, following long periods of time in the mouth, and often lose their elastic properties. They are mainly used for elastic ligatures **(Brantley ,1979; Baty ,1994).**

1.4 Classification of elastics

Elastics can be classified in many ways. According to the material, their availability, there uses and force **(Wong,1976).**

1.4.1 According to the material

- Latex elastics
- Synthetic elastics

1.4.2 According to the availability

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

1.4.3 According to the uses

This also can be classified in 2 ways.

1. **The first way :**

A) Intra oral elastics

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 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 sagittal 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 **(Alexander ,1986)**.

a. Elastic Chain

It is a chain of connected elastomeric rings, introduced to the orthodontic profession in 1960s as an alternative to latex elastic bands, and are now an integral part of many practices, (Figure 1). A number of manufacturers have produced different colors and different spans of filaments "continuous, short and long link" depending on whether or not there is a distance between the rings at its passive state and it is supplied in spools ***(*****Nattrass *et al.*, *1998)***.

The chain used as tooth-moving mechanism, are effective in closing diastema, correcting rotations or shifting of the midline and achieving general space closure **(Daskalogiannakis, 2000)**. They are inexpensive, easily applied, do not require patient cooperation and relatively hygienic **(Baty, 1994)**. Although larger spaces within the dental arch can be closed by sliding teeth with rubber bands or elastomeric chains, the same tooth movement can be done much more efficiently with A-NiTi springs that provide a nearly constant force over quite a large range **(Proffit and Fields, 2007).**

Elastomeric power chain is commonly used in orthodontics to facilitate tooth movement and consolidate space. These polyurethane materials are manufactured as a spool of linked elastic chain, which can be cut to the specific number of modules needed and due to the viscoelastic properties of power chain, however, the loss of force over time is inevitable and several studies have been done to illustrate this force decay **(Eliades *et al*., 2005) .**

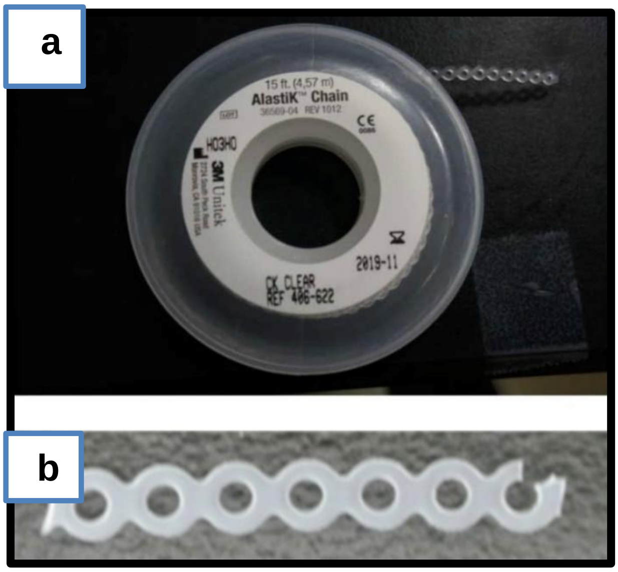

Figure 1: a and b : Power chain elastic**(Cheng *et al* ,2010)**

b. Elastic Separators

They are small-doughnuts shaped-modules or a dumb-bell shaped placed between the teeth to create a space by squeezing the teeth apart over a period of several days not more than one week as they can cause food stagnation **(Alexander, 1986)** (Figure 2). These separators make the band accurately placed, not distorted due to the tight inter proximal contacts which give a false impression of tightly fitting band **(Profit *et al*., 1997)**.

They are stretched with the help of special pliers or by pulling apart two pieces of dental floss threaded through it, while it is forced through the contact **(Daskalogianriakis, 2000)**.

The elastic separators become the most common devices used today. Brass wire can be used in adult patients with heavy tight contact and/or sharp amalgam fillings with broad contact that prevent the placement of elastomeric separator without distortion or breakage (**McGann, 1991)**.

Figure 2: Elastic separators **(Mitchell ,2013).**

c. Elastic ligatures

One of the most common methods of securing archwires to orthodontic brackets is the application of elastomeric ligatures (modules). Elastomeric ligatures are synthetic elastics made of polyurethane materials; however, the exact composition is proprietary information **(Young and Sandrik, 1979; De Genova *et al*., 1986; Ahrari, 2010)** (Figure 3) .

Elastic ligatures is a small round module that ties archwire into bracket slot ,and they are available in a variety of colors **(Alexander, 1986).**

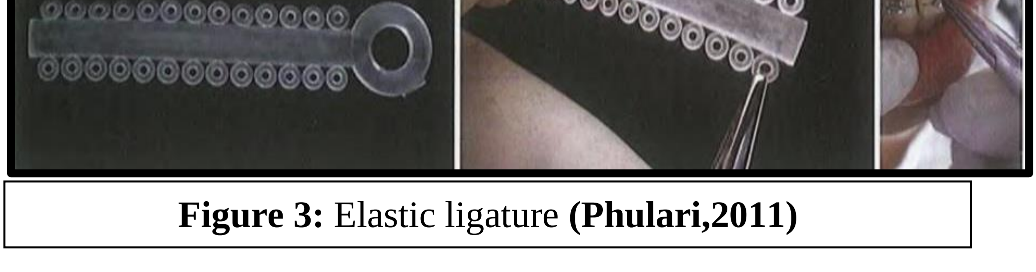

Figure 3: Elastic ligature **(Phulari,2011)**

- **Advantages and disadvantages of elastic ligatures:**
- **1) Advantages :**

1. Esthetically acceptable, especially with the ceramic bracket in which it increase its esthetic appearance **(Lew, 1990)**.

2. It is preferable to be used with ceramic bracket and plastic bracket to prevent the distortion and breakage of the tie wings due to brittleness **(Sorenson, 1991).**

3. Easily applied therefore takes less time **(Jeffries and von Fraunhofer, 1991).**

4. Inexpensive and available in different colors, so it is more favourable for young patient **(Storie *et al*, 1994)**.

2) Disadvantages:

1. Discoloration, after three to four weeks of time the elastic ligatures undergo change in there color so it need frequent replacement **(Obaid, 2007)**.

2. Less hygienic since the dentition and soft tissue may be adversely affected by microbial accumulation on the tooth surfaces adjacent to brackets ligated with elastomeric ligatures **(Forsberg *et al*, 1991).**

3. Arch wire may not be completely seat during torque or rotation correction **(Bednar and Gruendeman, 1993).**

B) Extra oral elastics

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 **(Singh *et al*,2012)** (Figure 4).

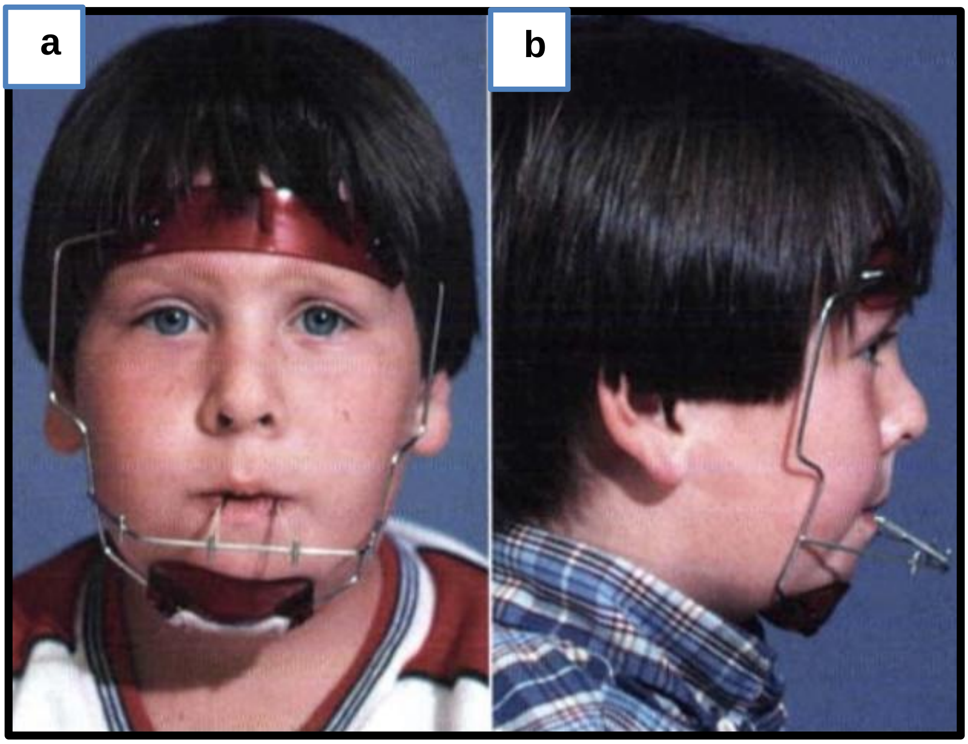

Figure 4: a and b :Extra oral elastic **(Proffit *et al*,2007)**

2. **The second way:**

a. **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 1⁄2 to 2 1⁄2 oz for non extraction cases and 2 to 4 oz. in extraction cases **(Bishara and Anderson 1970)** (Figure 5).

Figure 5: Class I elastic **(Greenberg ,2012)**

b. CL II Elastics / Intermaxillary elastics / Interarch elastics.

This is extended from the lower 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 **(Dermaut and Breeden ,1981)** (Figure 6).

Figure 6: CL II elastic **(Greenberg , 2012)**

c. 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 (Figure 7). 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 **(Anthony and Viazia, 1993)**.

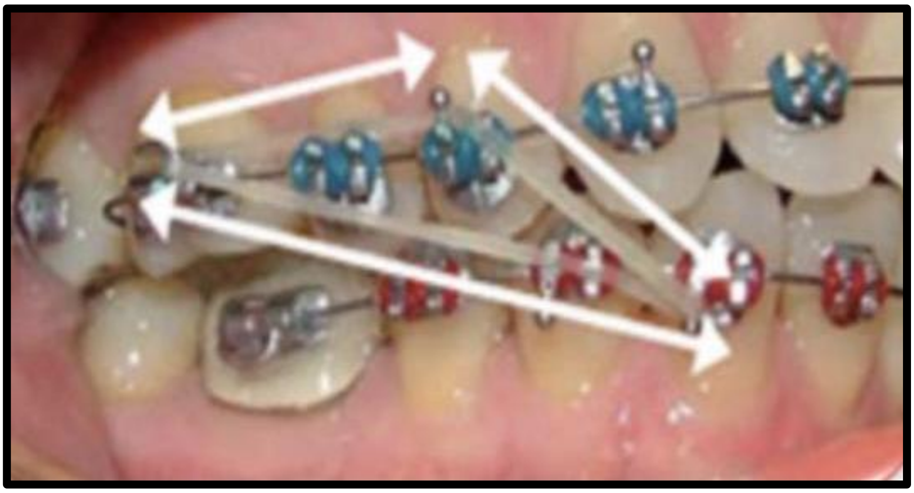

Figure 7 : CL III elastic (**Greenberg , 2012)**

d . 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 (Figure 8). 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 **(Anthony and Viazi,1993).**

Figure 8: Anterior elastic **(Mapare et al, 2018)**

e. Zigzag elastic

This is used for the rotation correction on the bicuspids. It is placed from bicuspid to cuspid and bicuspid to molar (Figure 9). This can cause undesirable molar movements also. This is indicated in extraction cases, and where spacing is present strong elastics are used **(Marpe *et al*,2018).**

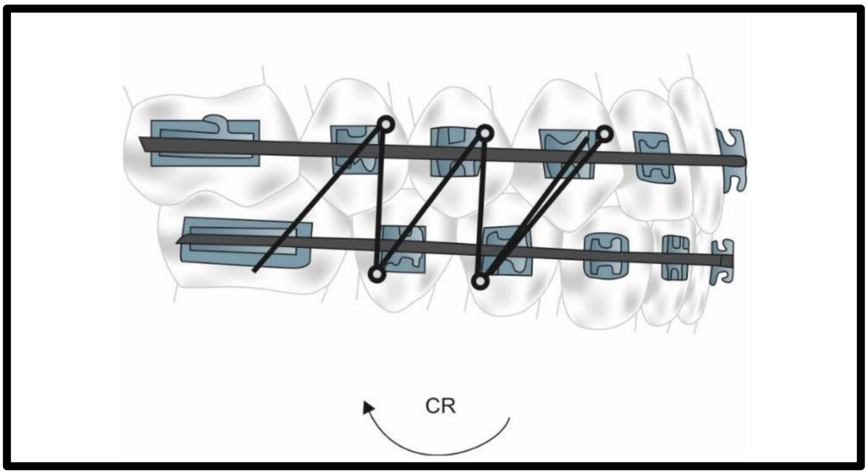

Figure 9: Zigzag elastic **(Marpe *et al*,2018)**

f. 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 **(Greenberg ,2012)** (Figure 10).

Figure 10: Cross bite elastic (**Littlewood,2019)**

g. 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 third stage is usually bilateral (Figure 11), 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 **(Singh, *et al*., 2012).**

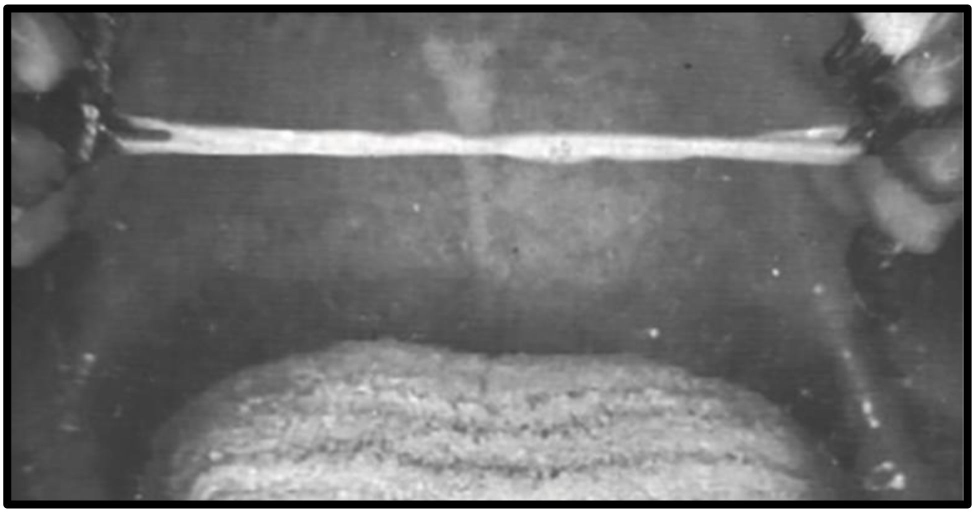

Figure 11: Cross -palate elastic **(Mapare *et al*, 2018)**

h. 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 (Figure 12). Force used is 1 1⁄2 to 2 1⁄2 ounces. It is also called as interior intermaxillary cross elastics **(Anthony and Viazi 1993).**

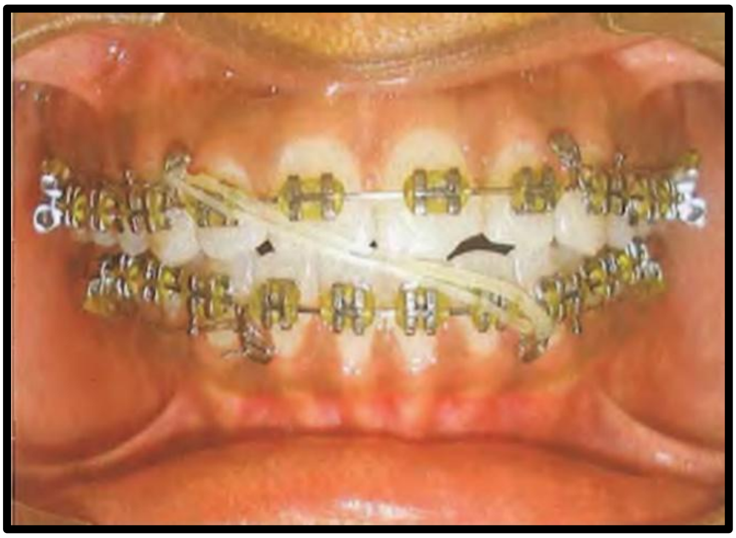

Figure 12: Midline elastic (**Phulari,2011)**

i. 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. **(Rinchuse ,1994)** (Figure 13).

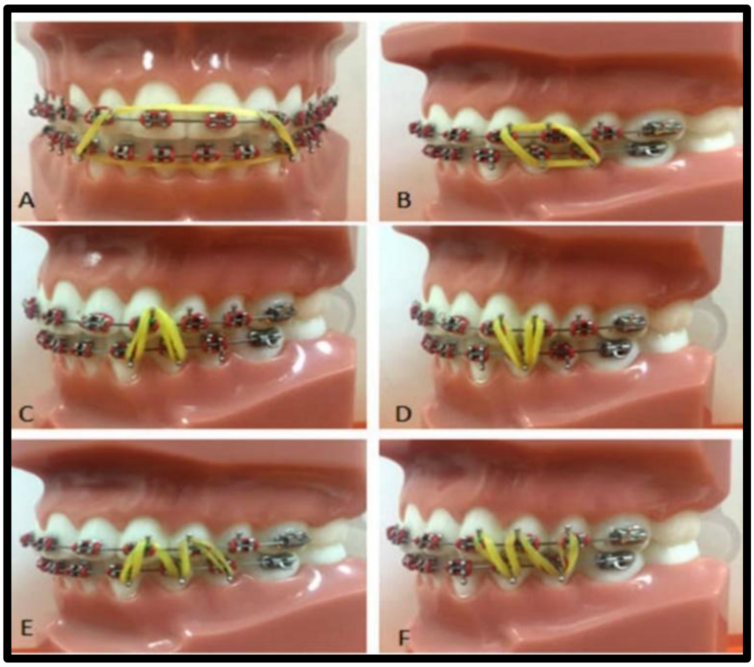

Figure 13: A,B,C,D,E and F :Open bite elastic **(Eltahir *et al* ,2017)**

j . Box elastics

Box elastics have a box shape configuration and can be used in variety of situations to promote tooth extrusion and improve intercuspation. 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 **(Kwapis and Knox , 1972)** (Figure 14).

Figure 14: Box elastic **(Phulari,2011)**

k . 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 rangeof 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 **(Anthony and Viazi ,1993)** (Figure 15).

Figure 15: Triangular elastic (**Greenberg , 2012)**

l . Elastics in removable appliance

Elastics in conjunction with the removal appliance are used for the movement of single and groups of teeth, and for intermaxillary traction. They can be used to move the impacted canine to a proper place along with the Hawley appliance **(Mapare *et al* ,2018)** (Figure 16).

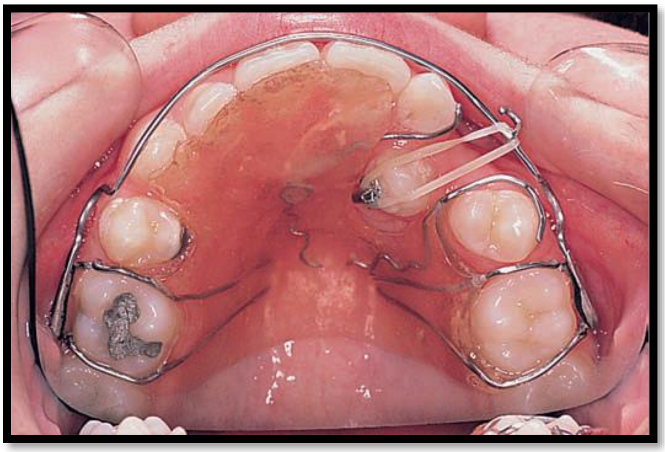

Figure 16: Elastic in removable appliance **(Mitchell, 2013)**

m. Other elastics

- **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 **(singh *et al*,2012).**

- **Finishing elastics**

Finishing elastics are used at the end of the treatment for final posterior settling. 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 **(Anthony and Viazi,1993).**

1.4.4 According to the force

1. High Pull

Ranges from 1/8" (3.2mm) to 3/8" (9.53mm). It gives 71 gm force (2 1⁄2 oz).

2. Medium Pull

Ranges from 1/8" (3.2mm) 3/8" (9.53 mm) it gives 128gm or 4 1⁄2 oz force.

3. Heavy pull

Ranges from1/8"(3.2mm) 3/8"(9.53 mm) It gives 184gm or 6 1/2oz force.

1.5 Force degradation:

Relaxation is defined as a decrease in force value carried or transmitted over time with the element maintained in a fixed activated state of constant strain. 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 3 hours in water bath. The force remained relatively the same throughout the rest of the period. There are a few general conclusions that can be drawn and applied clinically to all elastic types. Most marketed elastomeric chains generally loses 50–70% of their initial force during the first day of load application. At the end of 3 weeks they retained only 30–40% of the original force **(Asbell,1990).**

1.6 Latex Allergy

Latex is frequently utilized in dentistry as it present in various items, for example latex gloves, orthodontic elastics, and the dental rubber. However, it may induce various hypersensitivity reactions, such as latex hypersensitivity of the immediate type (type I) and the hypersensitivity of the delayed type (type IV) . The reason behind the hypersensitivity reaction is the latex proteins that have the ability to penetrate through the skin and/or the mucosa after direct contact, or after their inhalation via the respiratory system, inducing various reactions such as stomatitis, bronchospasm, or anaphylactic reaction **(Papakonstantinou and Raap, 2016)**.

Allergic contact dermatitis results in hand eczema and may show: (Blistering, weeping and fissuring) ,The mucosa may be involved in orthodontic patients wearing intra-oral elastics (Figure 17) The mucosa may become erythematous or the patient may complain of a burning or itching sensation in the affected area. A change in the brand of elastics or the use of non-latex elastics should resolve the symptoms **(Usatine and Riojas, 2010)**.

Ranta and ownby (2004) reefed to use the latex free inter-arch elastics and intra-arch elastics , metal ligatures or the use of self-ligating brackets instead of elastomeric elastics and Elastomeric separators can be replaced with self-locking separating springs

Figure 17: Mucosa lesion after using intermaxillary elastic **(pithon *et al* ,2012)**

1.7 Staining of Elastics

The staining of the Elastic polymers in the oral cavity can be attributed to the filling of the voids in the rubber matrix by fluids and bacterial debris. The polymers are degraded by ozone through an autocatalytic process. This decreases the tensile strength and flexibility of the Elastics. This oxidation process can be protected by the addition of antioxidants like phenyl alpha and beta naphthalamines **(Nattrass *et al*., 1998)**.

1.8 Fluoride release from orthodontic elastics

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 has been in use since the 1980s. In such device a copolymer membrane allows a reservoir of fluoride ions to migrate into oral environment rate **(Eliades *et al*., 2007).**

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 0.025 mg of fluoride is necessary for remineralization. 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 **(Miura *et al*.,2007)**

1.9 Pre-stretching of Elastics

(Wong 1976) suggested that the elastomeric materails need to be pre_streched1\3 rd of their length to pre-stress the molecular polymer chain. This procedure will increase the length of a material. If the material is overstretched a slow set will occur but will go back to the original state in time. If the material is overstretched to near breaking point, over and over again, permanent plastic deformation will occur. This means that the initial force may come to an effect during a pre-stretched process. So when it is in use it will give more stable force **(Mapare *et al* ,2018) .**

1.10 Elastics Storage

According to the manufactures, orthodontic elastics should be stored in the refrigerator, because increased atmospheric temperature for a long period will decrease the strength. Keeping in refrigerator (cool and dry) will give a long shelf-life **(Kwapis and Knox , 1972; Baty,1994).**

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Chapter two: Discussion and Comments

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. 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 **(Singh *et al* ,2012).**

Elastics can be classified in many ways: according to the material, their availability, their uses, and force. Natural rubber is the first known elastomeric, used by the ancient Incan and Mayan civilizations. Rubber-like materials that are made from chemicals were called synthetic rubber because they were intended as substitutes for natural rubber **(Marpe *et al*.,2081).**The major structural differences between natural rubber and synthetic elastics may account for a different long-term performance of nonlatex elastics **(Kersey *et al*,2003).**

Chapter three: Conclusion and Suggestions

3.1 Conclusion

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. Elastics are a prime consideration in orthodontics.

Elastics are one of the most versatile materials available to the orthodontist. Detailed medical history including latex allergies should be taken. If latex allergy developed during treatment, discontinue and use non latex elastics. Advised to use light force in non-extraction cases and medium too heavy for extraction cases.

3.2 Suggestions

- Making introductory brochures about elastics, their types and methods of use, according to orthodontic treated cases, and mentioning its properties, benefits and the allergic reaction that results from it.

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A

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