A REVIEW OF THE CLINICAL APPLICATIONS OF ELASTIC TRACTIONS IN ORTHODONTICS

Intermaxillary elastic traction to correct various malocclusions was first introduced in 1892 by Calvin Case. The types of elastics are distinguished according to their material, force production, and mode of application. All elastics vary in their characteristics presenting both advantages and disadvantages. Their composition plays an important role in their behavior when worn. The biomechanics of intermaxillary elastics determine their indications and contraindications. World J Orthod 2009;10:e12–e18.

Key words: elastics, intermaxillary, traction

It is well-known that nonprocessed rubber (latex) tends to be sticky at high temperatures but hard and brittle at low ones. In 1839, Charles Goodyear developed the vulcanization process that allowed the intentional distortion of latex. This was also used by orthodontists, who incorporated elastics into their treatments. Elastics produce light continuous forces that are most effective for tooth movement.3

Orthodontic elastics may be classified as intra- and extraoral, as inter- and intramaxillary, and as rings, chains, and threads.

This review will refer specifically to intermaxillary elastics, their advantages and disadvantages depending on the material they are made of, their indications and contraindications, as well as their behavior over the time of their application.

TYPES OF INTERMAXILLARY ELASTICS

Since Calvin Case1,2 introduced intermaxillary elastics in 1892, these devices have evolved. The various manufacturers classify them according to their passive inner diameter (in inches [1 inch = 2.54 cm]) and the force (in ounces [1 oz = 28.35 cN]) they generate when expanded to a length of three times their initial inner diameter. The inner diameter of elastics is often 1/4-inch, 3/16-inch, 1/8-inch, 3/4-inch, 3/8-inch, 5/8-inch, or 5/16-inch. Intraoral elastics produce forces between 2 to 6 oz4,5; intermaxillary forces are 6 oz.

According to their mode of application, elastics can produce primarily horizontal (intramaxillary elastics or Class II/Class III elastics), transverse (crossbite elastics), and vertical (up-and-down elastics) traction. Intermaxillary elastics that are applied in the mandible more distally than in the maxilla are called Class II elastics. Class II elastics usually have an inner diameter of 1/4 inch and produce a force of 6 ounces at 3 × 1/4-inch extension.4 Also, 3/16-inch elastics are recommended for Class II corrections.7, 8 Although Class II elastics are generally applied at the mandibular first molars and maxillary canines, their point of application may vary depending on their size and resulting force on the respective teeth.9 If the mandibular...
application point of an intermaxillary elastic is more mesial than the maxillary one, it is called a Class III elastic. Class III elastics usually have again an inner diameter of 1/4 inch, thus producing a force of 6.0 ounces. Yet again, 3/16-inch elastics are recommended to correct Class III relationships. Usually, they are applied at the mandibular canine and maxillary first molar. However, as with Class II elastics, their point of application may vary.

Elastics to correct crossbites are called crossbite elastics; their inner diameter is frequently 3/16 inch, so they also produce a force of 6.0 ounces. They are used in the posterior region and are usually applied ipsilaterally. Very rarely, they run to the contralateral side of a dental arch. Their points of application are the vestibular or oral sides of the posterior teeth, depending on the tooth movement desired.2,6

Elastic used for the extrusion of teeth may be applied on the anterior or posterior teeth. Again, these will often have an inner diameter of 1/4 or 3/16 inch. Elastics used at the finishing stage usually have a diameter of 3/4 inch, producing a force of 2 ounces. All these could be inserted to form a triangle, rectangle, trapezoid, M, W, or U, depending on the desired tooth movement.4,10

Finally, elastics are differentiated according to the material they are manufactured from: latex (natural), polyurethane, or silicone.11,12

ADVANTAGES AND DISADVANTAGES

The main advantage of intermaxillary elastics is that different forces can be easily created at very little cost.13 Thus, they can easily be replaced if they are worn out, they do not need to be reactivated, and their effect is reinforced when the mandible moves.2

The main disadvantage of intermaxillary elastics is that patients’ compliance is of critical importance, since lack of cooperation may be as high as 90%.14 Beside this, all elastomers are subject to fatigue resulting in force decay.7,15,18 This loss in elasticity may be exacerbated by unfavorable environmental conditions such as pH changes due to saliva, microbial plaque, or food.13 Bacteria may infiltrate the surface of elastics leading to discoloration.12,13,17–20 It is a common finding that elastics lose 10% to 40% of their initial strength within the first 24 hours in a humid (mouth/water) environment.13,17,21

A study of elastics from the same manufacturer revealed that latex samples preserve a higher percentage of their initial strength compared to nonlatex ones. Therefore, nonlatex elastics should ideally be changed every 6 to 8 hours.22 Another study showed that the inner diameter of nonlatex elastics—as compared to latex elastics—increased, while the force of both elastics were similar up to 2,400 loading cycles.23 After that, nonlatex elastics lost more of their initial strength. Other studies showed a low cytotoxicity12 for silicone as well as nonlatex elastics as opposed to latex elastics.22,24–36 Furthermore, silicone elastics demonstrated smaller strength differences in wet and dry environments. However, their initial strength was lower than that of latex elastics, and they presented a sudden loss of strength during extension.12

INDICATIONS, CONTRAINDICATIONS, AND BIOMECHANICS

Intermaxillary elastics should be worn throughout the day, except while eating or toothbrushing5,37; it is not uncommon that they are changed more than once daily.38 Basic applications of intermaxillary elastics include sagittal, transverse, and vertical malocclusions. Also, they are often inserted at the finishing stage of orthodontic treatment to settle the occlusion. Besides this, intermaxillary elastics are used postoperatively to immobilize both jaws28 or improve the occlusion.20

In any case, both dental arches should be stabilized with large diameter archwires before intermaxillary elastics are applied because unwanted movements of individual teeth can be avoided.2
Class II elastics develop two force components: horizontal and vertical (Fig 1). Due to the vertical force component, the mandibular posterior and maxillary anterior teeth will be extruded, which results in a clockwise rotation of the occlusal plane. Thus, the vertical force component should be as small as possible. This is achieved when the elastics are applied on the mandibular second molars and maxillary lateral incisors. The ideal indication for Class II elastics is a dentoalveolar Angle Class II. Besides this, a protrusion of the mandibular teeth, a rotation of the occlusal plane, and an extrusion of the mandibular molars and maxillary anterior teeth should not be critical. Class II elastics are contraindicated for patients with completed growth in whom a posterior rotation of the mandible would negatively influence facial esthetics. This holds especially true for patients with an increased anterior lower facial height. During mouth opening from 10 to 25 mm, the horizontal force increases by about 10% and the corresponding vertical force by 64%. Therefore, the vertical facial configuration should be taken into account. Furthermore, in patients with a large nasolabial angle, the distal movement of the maxillary teeth as the extrusion of the incisors can result in undesirable esthetics.

Finally, intermaxillary elastics should be used in only the permanent dentition. If the canines and premolars have not yet erupted, the extrusion of the maxillary incisors and mandibular molars will increase, as the neighboring teeth do not absorb some of the produced force. Furthermore, Class II elastics may be used preoperatively in patients with a skeletal Class III to decompensate existing dentoalveolar adaptations (Fig 2).

Class III elastics are applied in 5% to 10% of all patients with a mesioocclusion. In contrast to Class II elastics, they are applied earlier during orthodontic treatment. Whereas the posterior rotation of the mandible is very harmful in Class II patients, it compensates for some of the sagittal deviation in Class III patients. Ideally, such elastics are indicated in patients with an anterior crossbite due to a dentoalveolar or a mild skeletal Angle Class III that can be treated with opening the bite and rotating the mandible backward.
The goal of crossbite elastics is to correct an incorrect transverse relationship between the maxillary and mandibular posterior teeth. In growing patients, these elastics are not too harmful because the accompanying tooth extrusion is usually compensated by the vertical growth of the mandibular ramus. However, in adult patients, crossbite elastics should be used with caution, because there is a risk that they could cause an anterior open bite. It has been observed that the intermaxillary vertical force is three times as high as the horizontal one during mouth opening (Fig 3). This is also why such elastics should be used cautiously in children with an increased lower anterior face height or a reduced overbite. Crossbite elastics are rarely indicated for anterior crossbites.

To correct a midline deviation, midline elastics with Class II and/or III elastics can be used. Often, they are applied on the brackets of the maxillary and mandibular lateral incisors (Fig 5). It has been found that such elastics are more effective when used bilaterally rather than unilaterally.

A special type of up-and-down elastics often used in the final treatment stages are zigzag elastics. Posterior teeth that can be extruded more are released from the archwire. Generally, these elastics should not remain in the mouth for more than 2 weeks.

Similarly, Class III elastics extend from the maxillary molars to the mandibular canines to the maxillary canines. Both formations are subject to the contraindications for Class II and III elastics mentioned above. The side effects can be diminished with additional anterior trapezoid elastics applied on the lateral incisors if incisor extrusion can be tolerated, ie, there is no risk of creating a gummy smile (Fig 4).

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After termination of intermaxillary elastic use, the patient should be followed for a period of time to make sure that no rebound occurs. The best mode to conclude the application of intermaxillary elastics is to gradually reduce the forces they produce. Three to 4 weeks after the intended correction is achieved, these elastics are worn only at night for a given period of time before they are removed completely.20

As mentioned earlier, intermaxillary elastics are also used after orthognathic surgery (Fig 6). Their application points have to be chosen according to need. During the first 4 weeks, these elastics were worn all day (patient received liquid food). For the following 4 weeks, they were removed at meal times and worn only at night thereafter.20

**FORCE EXERTED BY ELASTICS**

The force stated by the manufacturer on the package is exerted when an elastic is extended to 300% of its original diameter.44 This norm of most manufacturers has been seriously disputed.13,22,34,44,45 According to Bales et al,46 the nominating force should be developed when an elastic is extended to twice its original diameter. Kanchana and Godfrey13 and Gioka et al44 observed that the force/extension ratio in a dry environment was seldom accurate.

**FORCE RELAXATION**

Numerous studies of elastics have found a loss of force in relation to length of use. Latex elastics lose around 13% of their initial strength in about 3 hours. This is followed by a further decrease of approximately 3%.46 Latex elastics 5/8 and 3/4 inch lose about 40% of their original strength after one day.17 Polyurethane elastics lose 50% to 75% of their original strength during the first 24 hours under tension, but after that, the force level remains relatively stable. Also, a continuous loading/unloading will significantly reduce the developed force magnitude. This is attributed to a structural change of the material.11,18,47–50 If, however, the loading cycles do not exceed 200, no significant difference in strength can be observed.48 Generally, significant differences in force decay exist depending on the size, manufacturer, and degree of extension. On average, loss rates are...
29.9% in the first hour, 32.6% in 24 hours, and 36.2% at the end of the third day. Force decline seems also to depend on the inner diameter, so smaller-sized elastics need to be replaced more frequently. But the force loss is also related to the material. In latex elastics, it amounts to about 25%; thus, the initial loss rate is higher. It appears 3 to 5 hours following extension, regardless of the size or manufacturer.

CONCLUSIONS

The authors concluded the following five points:

1. Elastics suffer a significant loss of strength with time, especially during the first hours of use.
2. Intermaxillary elastics should be applied with particular caution in patients with increased lower facial height or reduced overbite.
3. The desirable force of intermaxillary elastics is achieved when they are extended two to five times the length of their original inner diameter.
4. Nonlatex elastics should be changed more frequently than latex elastics to keep the force level constant.
5. Insufficient oral hygiene reduces the effectiveness of elastics.

REFERENCES


