Perceived vs measured forces of interarch elastics

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Introduction: Orthodontists depend on perceptions derived from education and clinical experience to judge the optimal forces in patient treatment. The purpose of this study was to survey practicing orthodontists to determine the interarch latex elastic forces they prescribe in different malocclusion scenarios. **Methods:** Thirty orthodontists were presented with 4 clinical scenarios on study models, including Class II and Class III malocclusions in edgewise and light wires. These orthodontists described the size and location of the elastics they would use. The forces produced by the prescribed elastics were measured and compared with actual dry forces measured on a testing machine. **Results:** The orthodontists' force recommendations were a mean of 277 ± 89 g and a median of 256 g (range, 132-464 g) for a Class II malocclusion with edgewise wires; a mean of 183 ± 59 g and a median of 177 g (range, 59-284 g) for a Class II malocclusion with light wires; a mean of 290 ± 83 g and a median of 305 g (range, 151-562 g) for a Class III malocclusion with edgewise wires; and a mean of 216 ± 66 g and a median of 209 g (range, 119-344 g) for a Class III malocclusion with light wires. The force levels for light wires were statistically significantly lower than for edgewise wires. **Conclusions:** There were considerable variations in the forces selected for all cases. "Expert" recommendations fell within 1 SD of the mean of the orthodontists' recommendations except for the light-wire Class III scenario. Since latex elastic force decays significantly during a patient's use, elastics should be selected with initially higher forces than desired. (Am J Orthod Dentofacial Orthop 2012;141:298-306)

Force levels in orthodontics are critically important, and orthodontists historically are conscientious in applying only the amount of force needed for healthy tooth movement, whether for archwire engagement in brackets, headgear force, or application of interarch elastics. Force levels, however, might be more in the area of art than of the science of orthodontics, with the art having a strong historical background. In 1910, Angle[1] wrote of the importance of light forces, stating that "when so used it should be very delicate, as described, so that only such gentle forces will be given to the roots of the teeth as to physiologically stimulate the bone-cells. Great force and rapid movement of the apices of the roots of the teeth the writer believes to be unphysiological." Reitan[2,3] later found that, with excessive forces, bone and periodontal ligament are compressed and undergo necrosis from ischemia created by blocked blood vessels. The osteoclasts and osteoblasts must then be recruited from healthy adjacent bone before the bone around the tooth can be remodeled. Owman-Moll et al[4] later confirmed the efficacy of light forces, finding that the "undermining resorption" method of tooth movement (heavy force) does not increase the rate at which a tooth will be moved. Although it appears logical that a tooth will move faster if more force is applied, the reality is that the rate of tooth movement is equivalent when comparing undermining resorption tooth movement and physiologic tooth movement. Proffit et al[5] agreed, stating that "heavy continuous orthodontic force can lead to severe root resorption." Other studies[6,7] concur that excess forces, including those from interarch elastics,[8,9] can damage the periodontal ligament, increasing the risk of root resorption. Excess force can also lead to increased pain. Proffit et al suggested that "when areas of periodontal ligament necrosis are avoided. . . pain is also lessened." It is clear from these findings that the use of optimal force levels is important.

The question then becomes what is the optimal force to accomplish orthodontic treatment goals, yet not be too heavy to cause pain and root resorption? Specific descriptions of optimal force magnitudes for interarch

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The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.
Supported by the University of Colorado School of Dental Medicine, Department of Orthodontics.
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Submitted, June 2010; revised and accepted, August 2011.
0889-5406/$36.00

doi:10.1016/j.ajodo.2011.08.027

latex elastics are difficult to find in the literature and are found primarily in textbooks. Nanda[10] stated that "an accurate measure of the optimal force eludes determination." Mulligan[11] acknowledged the difficulty in defining optimal force values when he stated that "an acceptable range of response . . . can vary greatly with each individual." Graber and Vanarsdall[12] made a similar statement regarding optimal force magnitudes but provided no specific, measurable forces.

Although the literature gives little evidence for optimal force magnitudes, several orthodontists regarded as experts have made recommendations for optimal forces when using latex interarch elastics. Proffit et al[5] listed 2 forces for ideal elastics forces, depending on the size of wire. When using large rectangular wires, he recommended approximately 250 g per side for interarch corrections in his latest textbook edition; this is a reduction from the 300 g in the earlier edition. When using a lighter round wire, Proffit et al recommended only half of the force used for the rectangular wires, or 125 g. Langlade[14] used estimates of root surfaces in conjunction with the suggestion of Ricketts et al[15] of 150 g per square centimeter of resorptive root surface for tooth movement to calculate the force needed to move the maxillary and mandibular dentitions en masse. Based on Langlade's calculations, an estimated force of 318 g per side would be required. The Alexander[16] discipline provides no force value but advocates the use of .25- in, 6-oz (0.64 cm, 170 g) elastics attached from the maxillary lateral incisor to the mandibular second molar in Class II corrections, and .25-in, 3.5-oz (0.64 cm, 99 g) elastics attached from the maxillary first molar to the mandibular canine.

The recommendations for interarch latex elastics forces are based solely on expert opinions. No studies have compared the experts' opinions to the actual forces used by practicing orthodontists.

The purpose of this study was to survey practicing orthodontists to determine the interarch latex elastic forces they prescribe in various malocclusion scenarios.

MATERIAL AND METHODS

Thirty experienced practicing orthodontists participated in this study, which included all full-time and part-time faculty (n = 15) at the University of Colorado School of Dental Medicine, Department of Orthodontics, and 15 additional orthodontists practicing in the Denver metropolitan area. The University of Colorado did not have an orthodontic training program until 2004, so the participating orthodontists reflect great diversity of training programs and geographic origins, including East Coast, West Coast, and Midwest. Of the 30 orthodontists, 3 did not follow the study protocol and were excluded. The remaining 27 orthodontists were considered representative of the orthodontic community.

A questionnaire and 2 sets of study models were presented to each orthodontist or clinician along with samples of all latex elastics in the study to allow them to feel the amount of force exerted. The orthodontists were allowed to apply the elastics to the models to determine the force. They were given instructions and asked to complete a questionnaire that allowed them to mark the size and location of the latex elastics that they would use to correct the malocclusion in each of the 4 cases. To prevent the confounding variable of intraoral force decay, the participants were told that the patient would wear the elastics for 20 hours per day and change them 3 times per day with the goal of obtaining a Class I molar and canine relationship. The 4 cases differed by the type of malocclusion and the archwire size. Case 1 described a patient in the finishing stages with an edgewise stainless steel archwire (0.018 × 0.025 in [0.45 × 0.63 mm]) and a half-step Class II malocclusion of both the molars and the canines. Case 2 was also a half-step Class II malocclusion but in an earlier stage of treatment with a lighter wire: a round stainless steel archwire (0.018 in [0.45 mm]). Both cases 3 and 4 were described as half-step Class III malocclusions, with an edgewise stainless steel archwire (0.018 × 0.025 in or 0.45 × 0.63 mm) in case 3 and a smaller round stainless steel archwire (0.018 in or 0.45 mm) in case 4.

The models had brackets attached to all teeth with cyanoacrylate (Super Glue; Pacer Technology; Rancho Cucamonga, Calif), and an archwire was in place. All brackets had hooks on the distal aspect of the bracket except for the molar tubes, which had distally curved hooks on the mesial aspect of the tube. Each selected bracket had a hook to allow the orthodontists to place the elastic in the desired position; the brackets were presented to the orthodontists as a generic appliance with only the above definitions and no technique or philosophy connection. The hooks allowed the orthodontists to attach latex elastics to any tooth on the model except for the central incisors. The models were trimmed to American Board of Orthodontics' specifications and stabilized in the described occlusion for each case by using hot glue on the lingual or palatal surface.

A reference box of latex elastics was included that contained a range of elastics (Rocky Mountain Orthodontics, Denver, Colo). The sizes were (1) 3/8 in (9.5 mm): 2 oz (57 g), 3 oz (85 g), 3.5 oz (99 g), 4.5 oz (128 g), and 5 oz (142 g); (2) 5/16 in (7.9 mm): 2 oz (57 g), 3 oz (85 g), 3.5 oz (99 g), 4.5 oz (128 g), and 5 oz (142 g); (3) 1/4 in (6.4 mm): 2 oz (57 g), 3 oz