CHAPTER 12

The Eureka Spring™: a compact, versatile, and cost-effective Class II corrector

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CONTENTS

Introduction

Diminished compliance among adolescents is a major concern of all healthcare providers. Even in such life-threatening conditions as sickle cell anemia,[1] renal transplant,[2,3] cancer,[4,5] and diabetes,[6,7] adolescent noncompliance is significant and approaches 50%,[2,3,8] with only 10% of patients showing excellent cooperation.[8] Additionally, it is difficult to predict the level of compliance at the onset of treatment[5,9,10] and clinicians experience waxing and waning levels of compliance over an extended treatment period.[2]

The initial motivation for trying a Eureka Spring™ will most likely come from working with the noncompliant patient who has consistently demonstrated insufficient wear of Class II elastics or extraoral headgear. With the resultant extended treatment time and inability to obtain the desired correction force, the clinician has to make one of two choices. First, treatment can be terminated with resignation that Class II correction will be incomplete. Second, a Class II correction appliance can be fitted which does not rely on patient cooperation.

Most of the appliances described in this book assume that noncompliance will be experienced and hence the treatment is planned accordingly from the onset. This applies to all the appliances described in Sections III and IV and most of those included in Section II. Some might argue that a number of those in Section II, such as the Herbst, Cantilever Bite Jumper, Mandibular Protraction Appliance, MARA, Sabbagh and Twin Force Bite Corrector, if used as a mandibular repositioning device, were chosen because of an orthopedic effect on the mandible resulting in a portion of the Class II correction derived from increased mandibular length.

However, long-term longitudinal evaluations of previously obtained increases in mandibular length by repositioning question the durability of the initial mandibular orthopedic gains.[11–14] If this is true, then only the dentoalveolar changes, at least in the mandible, are lasting and therefore these appliances were selected, for all practical purposes, in anticipation of noncompliance. Thus, only the Eureka Spring, Jasper Jumper, and the Twin Force, when not used to reposition the mandible anteriorly, can be used by the clinician who is experiencing unanticipated noncompliance during treatment.

The Eureka Spring should be thought of, at least initially, as an alternative to Class II elastics. Thus, Class II elastics and/or headgear are prescribed first. If cooperation is lacking and treatment time extended, a Eureka Spring can be offered to the patient. If compliance does not improve on the subsequent appointment, a Eureka Spring is placed.

The Eureka Spring differs from Class II elastics in many ways, including mechanism of action, insertion, management and relapse, and these differences will be discussed below. Because the Eureka Spring exerts a push rather than the pull force of Class II elastics, a Class II Eureka Spring attaches in the direction of a Class III elastic (Fig. 12.1). Given the same point of attachment, the horizontal component of the Class II vector will be similar in the two systems while the vertical component will be opposite, with Class II elastics extruding maxillary anterior and mandibular posterior teeth and potentially causing downward and backward mandibular rotation. With the Eureka Spring, the vertical component intrudes the maxillary molars and mandibular incisors, resulting in stable and upward and forward mandibular rotation.[15]

A further difference exists in mouth breathers and those patients with a tendency to keep their teeth apart. In these the extrusive component of the Class II vector increases when elastics are used while the intrusive component of the Eureka Spring diminishes.

The force vectors and duration of wear of Class II elastics can be varied by the clinician. These can also be varied with the Eureka

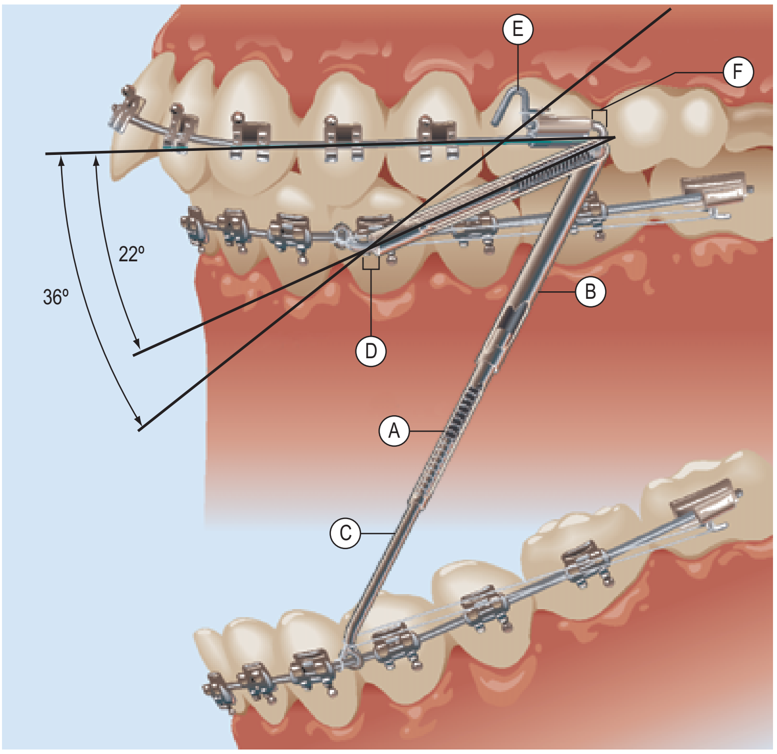

Figure 12.1 Components of the Class II Eureka Spring illustrated in a complete Class II occlusion with a 50 mm open-mouth position as produced by a hinge axis recorded articulator. The essential aspects include spring module A, molar attachment tube B, push rod C, free distance D, molar attachment wire E, free distance F.

Spring. If the Eureka Spring was viewed as an adjunct or alternative to Class II elastics, it would be prescribed frequently and the cumulative cost in an orthodontic practice would become significant and possibly limit its use to the most severe conditions. Fortunately, simplicity of design and manufacture permits the Eureka Spring to be relatively inexpensive, very cost-effective in comparison to extended treatment with Class II elastics, and hence could enjoy frequent use. I use the Eureka Spring on about 25% of patients during some portion of their active orthodontic treatment.

The Eureka Spring was first described in 1997 and treatment results on a variety of noncompliant Class II patients were presented.[16] The impetus behind its development was frustration with the increasing number of noncompliant patients and the frequent breakage of the Jasper Jumper, the best noncompliant treatment appliance available at that time.

Description

The essential components of the Eureka Spring are shown in Figure 12.1, in which the mouth is closed into a completed Class II condition and also opened to 50 mm. The spring module (A) slides within a molar attachment tube (B). A compression spring

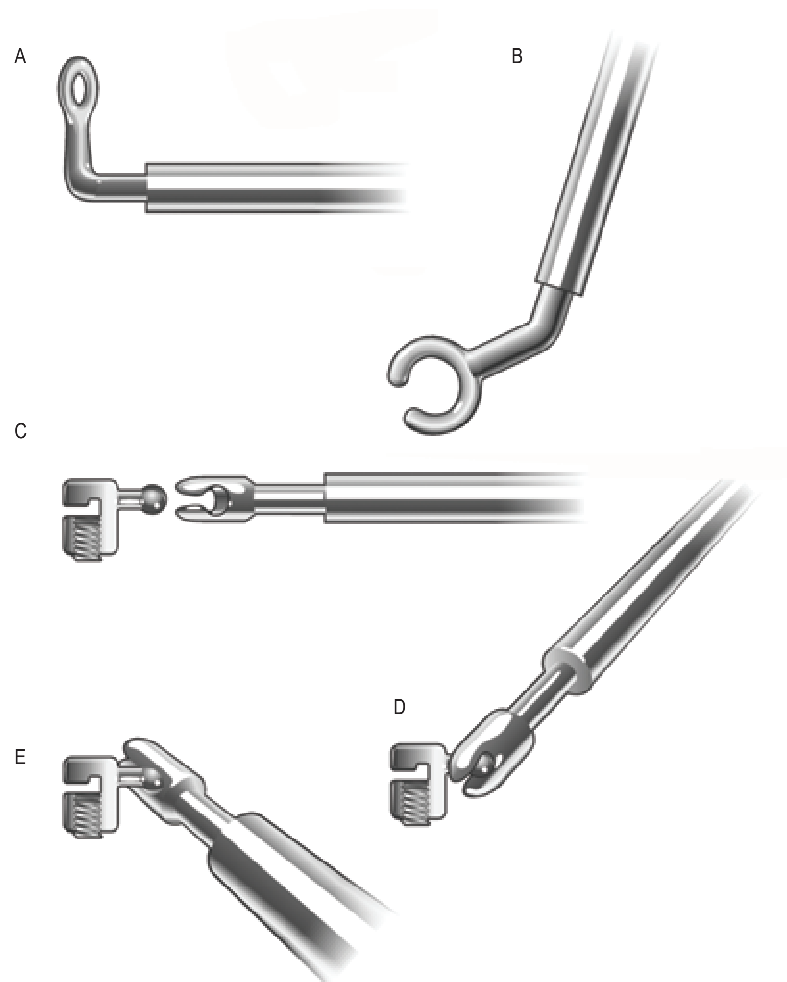

Figure 12.2 Choice of archwire attachments. Classic closed ring A, Classic open ring B, and Quick-Connect C, D, and E. In C, the spring module is inserted at its large opening E, then rotated 180° as shown in D, so the neck engages the narrow portion.

is encased within the spring module and drives the push rod (C) against the mandibular anterior teeth. It is important at insertion that the free distance (D), the distance from the elbow of the push rod to the open end of the molar attachment tube, be at least 2 mm when the mouth is closed. This free distance will extend the life of the spring and permit lateral excursions during mouth movements.

Several attachments to the mandibular archwire are available and illustrated in Figure 12.2. The *Classic closed ring* (A), the most popular model, requires archwire removal for insertion and removal, whereas the *Classic open ring* (B) permits attachment without archwire removal (the ring is gently crimped after insertion and one arm bent open for removal). The *Quick-Connect model* (C, D, and E) utilizes a block attached to the archwire from which a neck and sphere protrude. The spring module (A, Fig. 12.1) has been fitted with a receiving end on one side of which is an entrance slightly larger than the sphere on the block, while on the other side and joining the larger entrance is a slit slightly larger than the neck of the sphere. By inserting the sphere into the larger opening of the receiving end and then rotating the spring module 180° so that the narrow slit now engages the neck of the sphere (D), the spring module becomes fixed to the block. The Quick-Connect model permits rapid insertion without archwire removal and easy replacement of the spring module to one of greater or lesser force and/or distance as treatment progresses. When the desired Class II correction has been obtained, the spring module can be removed and the block used for intraoral elastics. Dental auxiliaries can easily place a Quick-Connect module in 1–2 minutes and remove it in half the time. This is comparable to the time taken to place Class II elastics if patient instruction time is included.

Figure 12.3 illustrates both the Classic and Quick-Connect models in a Class I molar relationship, in contrast to the Class II relationship depicted in Figure 12.1. Note the change in the angle of the force vector when going from Class II to Class I and also the slightly more horizontal vector of the Quick-Connect compared to the Classic model. It is also important to observe the very unfavorable vector generated when the maxillary attachment is placed mesial of the first molar (see Fig. 12.1). This becomes particularly important in severe Class II conditions.

Light (150 g) and heavy (225 g) spring force modules, depending on the configuration of the internal spring, are available. In adult patients requiring significant Class II corrections, the heavy spring module should be considered. In very young patients the light force module is preferred. In mid- to late-adolescent patients, both modules are used. If there is a bilateral Class II, more severe on one side, the heavy force spring module may be placed on that side while the light force module can be used contralaterally. The heavy force module will correct sagittal discrepancies more rapidly and will also produce more maxillary posterior dental intrusion.[17]

Extending from the distal aspect of the molar attachment tube (B, Fig. 12.1) is an 0.85 mm attachment wire (E, Fig. 12.1) with a ball end enclosed within the molar attachment tube. This attachment wire inserts from the distal into an auxiliary molar tube which must be at least 0.90 mm ID. At its anterior end it is secured to the hook on the molar tube. Adjustments in the attachment wire permit alterations in the vertical component of the force vector, as shown in Figure 12.4. Bending the attachment wire as in (A) will produce the largest intrusive component, whereas bending as in (C) will produce the least intrusive component. (Avoid bending the attachment wire completely vertical, because the hinge motion of the ball on opening may be limited.)

The ability to manipulate the force vector can be invaluable in obtaining rapid orthodontic treatment and is often overlooked. For example, in an anterior deep bite a vector producing more vertical intrusion as in (A) (Fig. 12.4) should be generated, whereas where no anterior overbite is present the clinician would be wise to create a vector nearly parallel to the occlusal plane, as depicted in (C). In the transverse dimension, if no transpalatal arch is used, greater buccal crown torque will occur in attachment method (A) than in (C). This would be desirable for correction of some malocclusions but very undesirable for others.

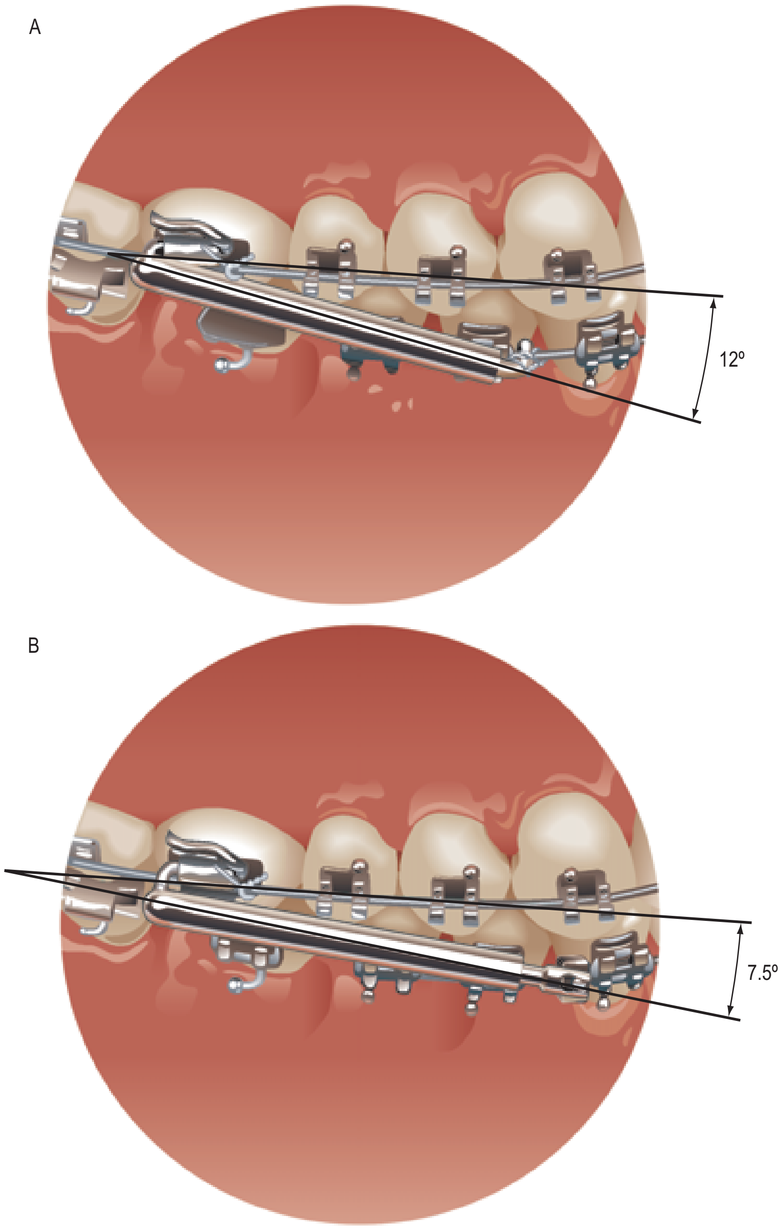

Figure 12.3 The Classic A and Quick-Connect B models in the closed-mouth Class I position. Note the change in the vectors (black lines), particularly comparing Fig. 12.1 Class II with Fig. 12.3 Class I.

Moments, Forces, and Vectors

The three dimensions of forces acting on the dentition can be seen in Figure 12.5, and close examination will indicate the expected clinical results of Eureka Spring therapy. In the buccal vector, the larger horizontal component will produce the desired sagittal Class II correction while the vertical component should produce maxillary molar and mandibular anterior intrusion.[15] This secondary intrusion effect which would facilitate correction of a severe Spee curve or

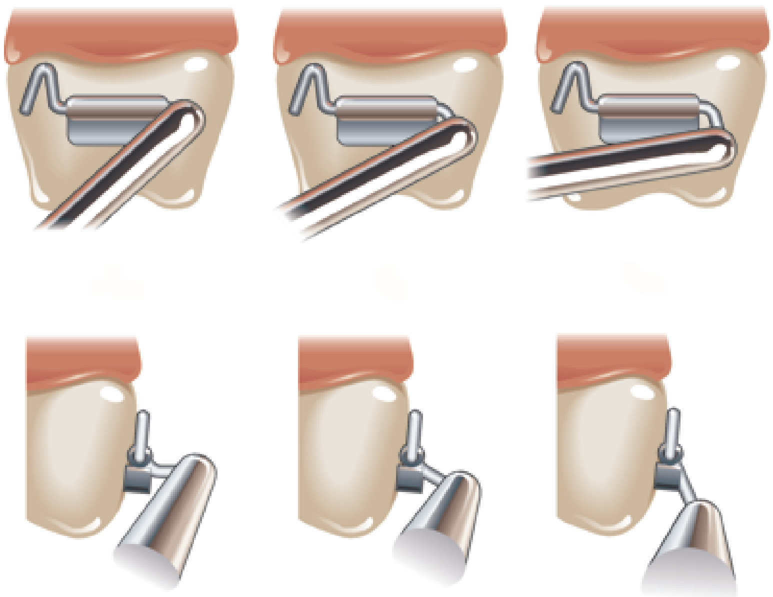

Figure 12.4 By changing the configuration of the attachment wire, the vertical component of the vector can be manipulated.

anterior overbite, often associated with Class II malocclusions, can be increased by manipulating the buccal vector as shown in Figure 12.4. However, if little curve of Spee exists along with a tendency for anterior open bite, Eureka Spring treatment should be combined with anterior vertical elastics, an increase in the curve of Spee in the mandibular archwire or a decrease in the vertical component of the buccal vector (see Fig. 12.4). The molar intrusive component would be welcomed in dolichofacial types, who are just the patients in whom Class II elastics are frequently contraindicated. However, in severe brachyfacial Class II patients, maxillary molar intrusion may not be desirable and the Eureka Spring contraindicated.

Manipulation of the vertical component of the buccal vector can be important. This is accomplished easily either at insertion or on subsequent appointments by modifying the direction the attachment wire (E, Fig. 12.1) takes as it emerges from the distal of the molar tube (see Fig. 12.4). It is noteworthy that the teeth drawn in Figure 12.5 are in a Class I relationship. The more Class II the original malocclusion, the greater will be the vertical (intrusive) component of the buccal vector. Likewise, the more anteriorly the maxillary attachment is placed, the greater the vertical component and the slower that sagittal correction will occur. This combination of sagittal and vertical effects explains why the Eureka Spring is not attached at the mesial of the maxillary molar.

The clinician should consider extension of the maxillary archwire through the second molars if prolonged Eureka Spring therapy is anticipated. Additionally, the heavy Eureka Spring will produce a larger vertical component than that resulting from a light Eureka Spring.[17] However, shorter treatment time with the heavy Eureka Spring may reduce the total vertical force exerted on the dentition over the timespan of Eureka Spring treatment.

The sagittal correction produced by the horizontal component of the buccal vector will mesialize the mandibular dentition while causing posterior migration in the maxilla. To some extent differential movement can be obtained. For example, a large rectangular archwire (0.43 × 0.64 in a 0.46 × 0.61 slot) with palatal root torque to the maxillary incisors and second molars engaged along with a small mandibular rectangular archwire (0.41 × 0.56 in a 0.46 × 0.61 slot) with anterior lingual root torque and without second molars will result in as much as 80% of the correction occurring in the mandibular dentition. Likewise, with the reverse anchorage the clinician can expect as much as 80% of correction to occur in the maxillary dentition.

Stromeyer et al found all of the above-mentioned expectations at clinically significant levels.[15] When 10–15° of labial root torque was placed in the anterior region of the mandibular 0.41 × 0.56 archwire in 0° 0.46 × 0.64 slots and a similar sized wire and amount of palatal root torque was placed in the maxillary anterior archwire in Roth prescription anterior 0.46 × 0.64 slot brackets, the maxillary dentition migrated distally an amount equal to the anterior migration of the mandibular dentition. Likewise, for every 3 mm of sagittal correction, 1 mm of maxillary molar and mandibular incisor intrusion was measured. Also, as expected, in the subset of the dolichofacial patients neither the mandibular plane angle nor anterior face height increased during sagittal correction.

An examination of the occlusal vector (see Fig. 12.5) would increase the clinician's awareness of the potential for the aforementioned sagittal correction along with maxillary molar expansion and mesiobuccal rotation and mandibular anterior constriction. This is readily observed in practice. Therefore, if some maxillary constriction along with mesiobuccal rotation is present initially, the Eureka Spring will aid in this correction. However, if the buccal maxillary molar relationship is acceptable, either the maxillary arch must be constricted or a transpalatal arch placed. Clinical experience has shown that a 0.41 × 0.56 constricted maxillary archwire with 15° of buccal root torque has insufficient resistance to counter the expansive force of the light Eureka Spring.

When bilateral Eureka Springs are used, the expected constriction in the mandibular arch is not observed. However, if a unilateral Class II Eureka Spring is placed, visible skewing of the arch, lingual on the treatment side and buccal on the contralateral side, is observed frequently with small rectangular archwires (0.41 × 0.56).

From the frontal view (see Fig. 12.5) one can recognize the impacts of the Eureka Spring in the three dimensions. Maxillary molar expansion caused by buccal crown torque, mandibular anterior constriction resulting from lingual crown torque, and varying degrees of intrusion depending on the vector direction are apparent.

Focusing on the three moments acting on the maxillary molars (see Fig. 12.5) reveals the increased adverse effects of Eureka Spring therapy on these teeth. These undesirable effects can be clinically negated by using a transpalatal bar and archwire engagement into the second molars. This should always be considered if more than

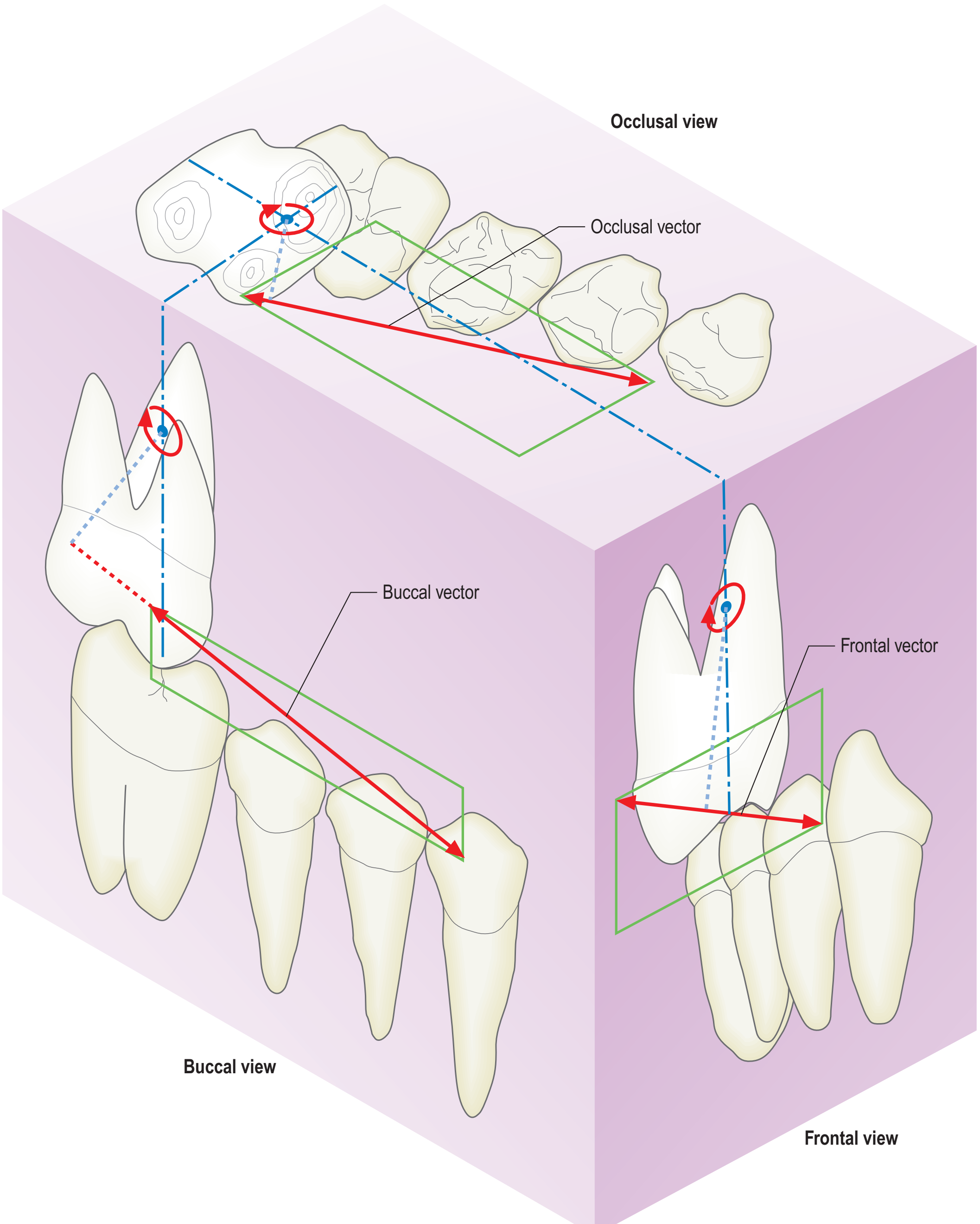

Figure 12.5 Three-dimensional model of the forces acting on the dentition, with primary emphasis on the molar. The centerline (alternating long and short dashes) connects the approximate center of resistance (blue spot) of the molar in each view. The short dashed blue line going through the center of resistance is used to demonstrate the produced moment, which is represented as the red circular arrow around each center of resistance. The components of the vectors in each view are shown by the green rectangles.

2.5–3 mm of sagittal correction is needed. In other words, if active Eureka Spring treatment is expected to extend past 3–4 months (rate of sagittal correction is about 0.7 mm per month at 150 g of force and 0.85 mm at 225 g),[15] the treatment plan should include a transpalatal arch and incorporation of second molars.

Some clinicians use a 0.35 ligature wire engaging the first or second molar and functioning as both a tieback and tiedown of the push rod, as shown in Figures 12.1 and 12.3. Others prefer a short piece of power chain attached mesially on the cuspid and distally at a bicuspid or molar, whereas some attach the power chain directly to the archwire mesial of the push rod, going occlusally over the push rod and then attaching to a bicuspid or molar.

Insertion, Routine Management, and Patient Motivation

The Eureka Spring should not be placed on a round wire in the mandibular arch. The smallest mandibular rectangular wire should be 0.41 × 0.56. In the maxillary arch, rectangular wires are generally preferred but if a transpalatal bar is used and maxillary second molars engaged, no anterior archwire or bonding is required, although interarch anchorage manipulation then becomes limited.

The most important step in insertion of a Eureka Spring is to obtain 2 mm of free distance between the push rod (D, Fig. 12.1) and the anterior edge of the molar attachment tube (B, Fig. 12.1). Other important insertion aspects include stabilizing the push rod (C, Fig. 12.1) in the Classic models, to prevent its rotating occlusally. The attachment wire can be adjusted either at insertion or during treatment to influence the magnitude of the vertical component of the Class II vector (see Fig. 12.4). Generally a more horizontal vector, i.e. as parallel to the occlusal plane as possible, is preferred (C, Fig. 12.4) but in severe overbite caused by extrusion of mandibular anterior teeth, a more vertical vector (A, Fig. 12.4) may be utilized.

Depending on the angulation of the molar attachment or the arch form (more tapered than ovoid), more offset of the molar tube than provided by the manufacturer's initial bend of the attachment wire may be required. Occasionally this offset must be increased to prevent occlusal interference with the attachment on the mandibular first molars. This is discussed in the instruction manual or can be viewed on the web page: www.eurekaortho.com

Other important steps include securing the mesial aspect of the attachment wire to the hook on the molar band and maintaining at least 2 mm of free distance in the attachment wire (F, Fig. 12.1). Complete instructions accompany the product and can be viewed on the web page.

After insertion, the most important management practice is the evaluation of the push rod on each subsequent appointment to assure that the remaining force of the internal spring is adequate. The greatest weakness of the Eureka Spring is premature breakage of the internal spring, and hence reduced force. This will not be apparent to the patient or on casual clinical evaluation. The tension should be checked and if the remaining force is deemed inadequate, the spring module should be replaced. Frequently there is sufficient force remaining to complete the Class II correction even if the spring within the spring module (A, Fig. 12.1) has broken.

If using Class I forces in combination with Eureka Spring, as occurs often in extraction cases, alterations in these two force systems during treatment should be considered so that pretreatment goals can be obtained. One or two progress cephalograms may be valuable to aid in these adjustments.

Tissue irritations are infrequent at the corners of the mouth but are more common in the buccal corridor distal to the maxillary molar. Often this is on one side only and corresponds to the patient sleeping on the irritated side. To help alleviate this problem, the molar attachment tube can be positioned more horizontally or the patient can be instructed to press against this tube occlusopalatally and in so doing bend the attachment wire.

In some patients with mouth opening wider than 55 mm, the spring module can occasionally become disengaged from the molar attachment tube. Instructions at insertion include how to reinsert these parts.

It is not uncommon to schedule appointment intervals of 2 months when Eureka Spring therapy is in progress. More frequent appointments permit the clinician to make archwire adjustment bends with the goal that within 3–5 months of cessation of Eureka Spring therapy, active treatment should be completed.

As the Class II correction occurs and the free distance increases, the force from the Eureka Spring will diminish. To decrease the free distance to its initial 2 mm, the clinician may pull the attachment wire mesially and rebend, distalize the anterior contact on the mandibular archwire, or crimp the molar attachment tube with a ligature cutter just mesial of the inserted ball. (The mouth must be opened wide during this crimping to avoid also crimping the sliding spring module.)

A final comment on patient motivation may be helpful. In my practice the Eureka Spring is frequently viewed as an alternative to interarch elastics, with the added benefit of no extrusive vertical component. For the average patient Class II elastics and/or neck gear are prescribed for one appointment. If wear is inadequate, the patient is given the choice of Eureka Spring or another try at elastics and/or neck gear. On the subsequent appointment, if wear is still inadequate, Eureka Springs are inserted or two or more bicuspids are removed. Later, should the patient wish to try elastics again, the opportunity is given. Because of its small size, appealing esthetics, speed of treatment, and elimination of the need for constant replacement of Class II elastics, the Eureka Spring alternative is initially selected by about half of patients.

In the dolichocephalic patient with initial gingival display on smiling, the Eureka Spring is always prescribed at the onset. Likewise, in the brachycephalic patients, Class II elastics are the treatment of choice and Eureka Springs offered only as a later alternative.

Applications and Treatment Planning

Once the clinician has become comfortable with the insertion and management of the Eureka Spring appliance and office protocol utilizing this versatile tool has become routine, thoughts regarding actual treatment planning will naturally follow and information on this can be found in previous[18] or upcoming publications.[19]

In the nonextraction Class II patient, leveling and aligning are first accomplished. This should include engagement of the maxillary second molars if possible and the placement of a transpalatal arch. The Eureka Spring should not be inserted until rectangular wires of at least 0.41×0.56 are in place. Appropriate sizes and torques, to accomplish desired anchorage and obtain necessary anterior root angulations, are made at this time.

If much maxillary arch retraction is desired, a headgear or cervical gear can be worn 10 hours per day. This combination of intermittent heavy extraoral force coupled with continuous light intraoral Eureka Spring force routinely corrects full Class II malocclusions into Class I dental relationships in less than 6 months. To accomplish this, either two sufficiently large tubes or modified bending of the attachment wire, as shown in Figure 12.6, is required if a single large