11.2

Rational Diagnosis and Treatment of Dental Asymmetries

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CHAPTER MENU

Introduction

Dental asymmetries are considered as one of the most difficult scenarios to manage in orthodontics. A correct differential diagnosis constitutes the cornerstone for any biomechanical application. These asymmetries could be classified by their location as either posterior or anterior, by their orientation in the occlusal, the sagittal, or the frontal plane, and by their etiology which could be dental, functional, or skeletal. Anterior asymmetries are generally more difficult to treat due to their interaction with smile esthetics. Posterior asymmetries, which are more discrete, have to be also considered for a better occlusal intermaxillary relationship and in the pursuit of excellence in orthodontics. The aim of this chapter is to identify different types of dental asymmetries, to develop a differential diagnosis, and to apply individualized treatment mechanics depending on each case.

The objectives of orthodontic treatment encompass dentofacial esthetics, functional occlusion, periodontal health, and stability. As Peck et al. (1990) mentioned, symmetry plays an important role in dentofacial esthetics. Asymmetry may be expressed as mandibular deviations, occlusal cants, dental midline shifts, or simple gingival height discrepancies (Sarver and Ackerman 2003). Perfect symmetry seldom occurs in nature, however, and the development of the human face and dentition is no different (Lundstrom 1961).

Some degree of facial and dental asymmetry occurs in virtually all individuals (Bishara et al. 1994; Ferrario et al. 1993; Ming 2006; Sheats et al. 1998; Smith and Bailit 1979; Yoon et al. 2013). Facial asymmetry can have dental, functional, or skeletal causes or a combination of

Dentofacial and Occlusal Asymmetries, First Edition. Edited by Birte Melsen and Athanasios E. Athanasiou.

the three (Bishara et al. 1994; Joondeph 2000). An asymmetry in a single dimension has the potential to cause other asymmetries in other dimensions within the craniofacial complex. The question then arises: What is a clinically acceptable asymmetry for the various dentofacial features? Beyer and Lindauer (1998) suggest midline asymmetry greater than 2.2 mm is discernible. Choi (2015) suggested that facial asymmetries within 3–4% and 3–4 mm are not clinically detectable.

According to Sheats et al. (1998), the most common asymmetries in patients presenting for orthodontic treatment were mandibular midline deviation from the facial midline, occurring in 62% of patients, followed by lack of dental midline coincidence (46%), maxillary midline deviation from the facial midline (39%), molar classification asymmetry (22%), maxillary occlusal asymmetry, (20%) and mandibular occlusal asymmetry (18%). Facial asymmetry (6%), chin deviation (4%), and nasal deviation (3%) made up the remainder.

Dental deviations should be treated as far as possible with intra-arch mechanics, functional deviations with inter-arch mechanics, and skeletal deviations with orthognathic surgery. While some degree of asymmetry is definitely part of natural appearance, symmetry is the ideal that we should treat toward (Pinho et al. 2007).

Classification of Dental Asymmetries

Facial asymmetry can be classified into skeletal, functional, or dental. Dental asymmetries, although somewhat associated with skeletal asymmetry, can be categorized into posterior and anterior depending on their location.

The posterior asymmetries can then be further classified into occlusal, sagittal, and frontal plane asymmetries, while anterior asymmetries can be divided into asymmetries of dental, functional, or skeletal origin.

Diagnosis of Dental Asymmetries

The diagnosis of asymmetry follows the traditional comprehensive orthodontic clinical examination including photographs, study models, occlusograms, and cone beam computed tomography (CBCT) (or panoramic radiograph, lateral cephalometric radiography, submental cephalometric radiography, and frontal cephalometric radiography, if a CBCT is unavailable).

The extra-oral clinical examination of asymmetry is performed with the patient in the natural head position and involves utilizing some specific facial planes and landmarks, i.e. the interpupillary line, and a vertical line through the glabella perpendicular to the inter-pupillary line, tip of the nose, and center of the philtrum and chin (Figure 11.2.1). The clinical examination for asymmetry can be performed by looking from a frontal view. In addition, looking from inferior view of the mandible can aid in determining the extent of deviation (Cheney 1961) (Figure 11.2.2). Alternatively, a straight instrument or piece of floss placed in line with the facial midline can aid in visualization of asymmetry (Figure 11.2.3).

A frontal facial photo is ideal to investigate asymmetry, where the anatomical landmarks and constructed lines can be drawn digitally and compared, which may be awkward when done in-person. The presence of an occlusal cant should also be assessed at this stage. This can be done by asking the patient to bite on a tongue blade which is positioned in the canine area, and comparing it to the interpupillary line (Arnett and Bergman 1993) (Figure 11.2.4). Furthermore, a frontal examination of the patient smiling, with their mouth closed and then slightly opened, will also aid in observing any asymmetry of the smile or cant of the occlusal plane, respectively.

Figure 11.2.1 An extra-oral clinical examination utilizing the interpupillary line, and a vertical line through the glabella perpendicular to the interpupillary line.

Figure 11.2.2 A clinical examination can be performed by looking from inferior view of the mandible.

Figure 11.2.3 A straight instrument or piece of floss placed in line with the facial midline can aid in visualization of asymmetry.

A clinical examination should involve screening for functional asymmetries such as mandibular dental midline deviations during opening, centric relationship, first contact of the occlusion, and in occlusion (Bishara et al. 1994). True dental or skeletal asymmetries will exhibit similar midline discrepancy in both centric relation and centric occlusion. Conversely, functional asymmetries due to occlusal interferences will show a midline discrepancy between centric relation and centric occlusion as the mandible shifts laterally.

Moving intra-orally, the facial midline is coincident with the upper lip philtrum and the midpalatal suture, and these landmarks should be used when measuring the upper dental midline deviation. In both the upper and lower arches, the labial or lingual frena should not be used

Figure 11.2.4 The presence of an occlusal cant assessed by asking the patient to bite on a tongue blade and comparing it to the inter-pupillary line.

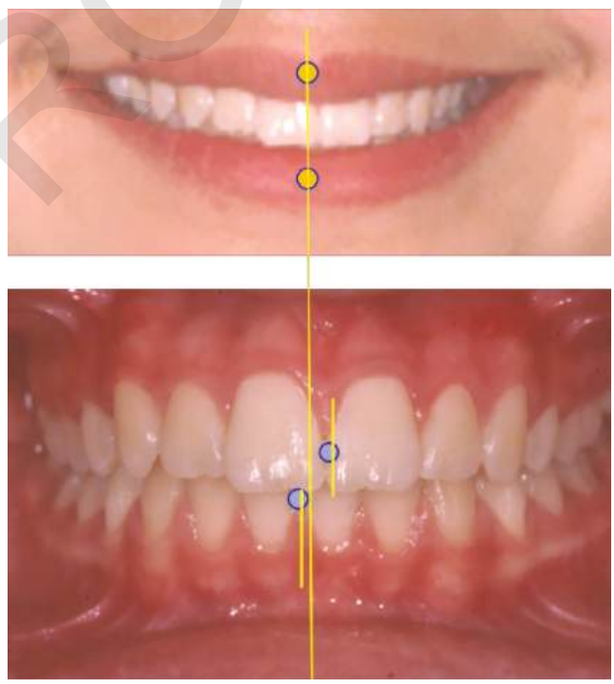

Figure 11.2.5 Examination of dental midline asymmetry.

as a reference landmark, due to their alveolar insertion which adapts and alters based on tooth position (Figure 11.2.5).

Dental arch asymmetry should also be investigated at this point and can be further inspected using a dental cast. The dental cast can also be investigated for asymmetry via an occlusogram, which involves the use of a grid to aid in measurement of dental arch asymmetries (Faber 1992;

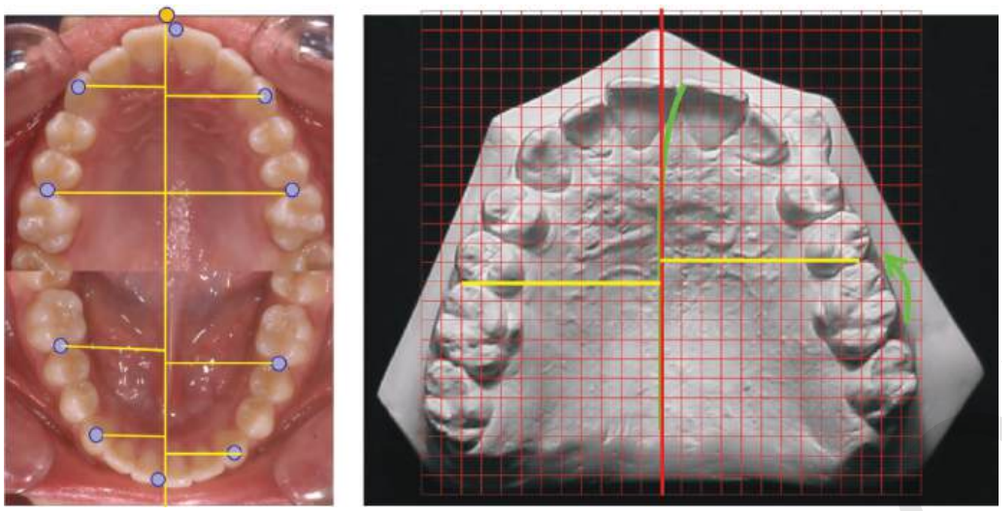

Figure 11.2.6 Asymmetry of dental arches evaluation.

Fiorelli and Melsen 1999; White 1982). This allows for discrete measurements of the left and right differences and asymmetries in different planes (Figure 11.2.6).

Dental arch asymmetries can be caused by skeletal factors, such as the rotation of the entire dental arch and the maxillary base, or by local factors such as the premature loss of primary teeth. Asymmetry of the buccolingual inclination of the posterior teeth, especially in cases with a unilateral crossbite, should be assessed to determine if an asymmetry is of dental, functional, or skeletal origin.

In certain cases, where the cause of asymmetry is unclear, a therapeutic diagnosis can be attempted. An outwardly apparent asymmetric occlusion may become symmetric after leveling and aligning of the arches or via the use of an occlusal splint. This usually manifests itself when there is an initial premature contact that causes a functional mandibular deviation.

The radiographic examination for asymmetry should start with conventional panoramic and cephalometric radiographs. The panoramic radiograph enables the clinician to view the condyles for size and shape discrepancies, as well as irregular cortical borders (Figure 11.2.7). While the condylar length and ramus length may be measured as well, positioning errors of the patient tends to make these measurements unreliable and is better evaluated using CBCT.

A lateral cephalometric radiograph can be used to identify mandibular asymmetry by observing the two borders of the mandible (Figure 11.2.8). This also has some reliability issues, however, as the patient's head positioning may lead to small discrepancies between the borders of the mandible (Bishara et al. 1994). Hence only gross and obvious asymmetry can be reliably identified. Frontal and submental cephalometry has been the traditional go-to method for evaluating skeletal asymmetry due to the right and left

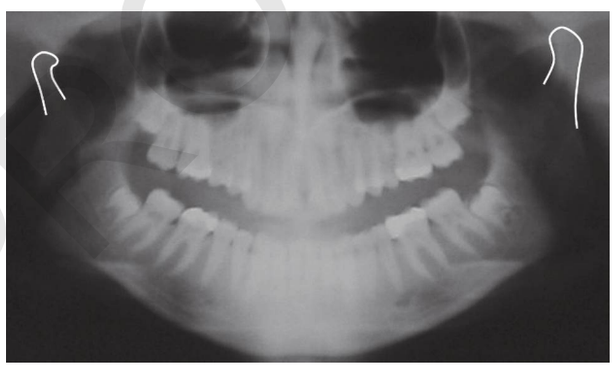

Figure 11.2.7 Panoramic radiographic examination.

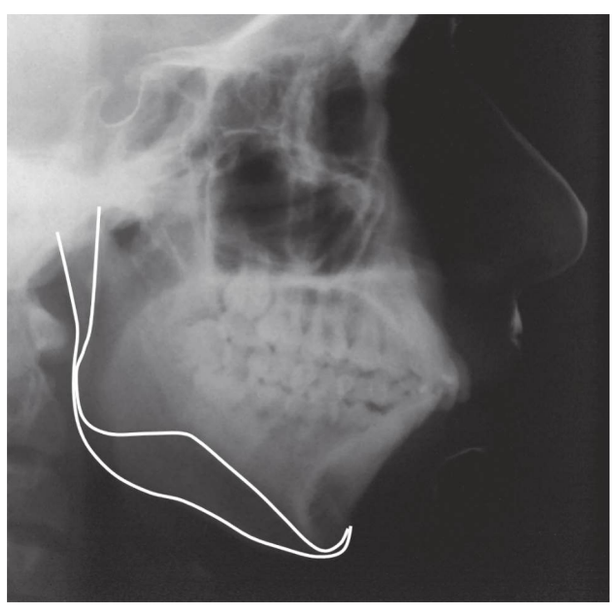

Figure 11.2.8 Identification of mandibular asymmetry on a lateral cephalometric radiograph.

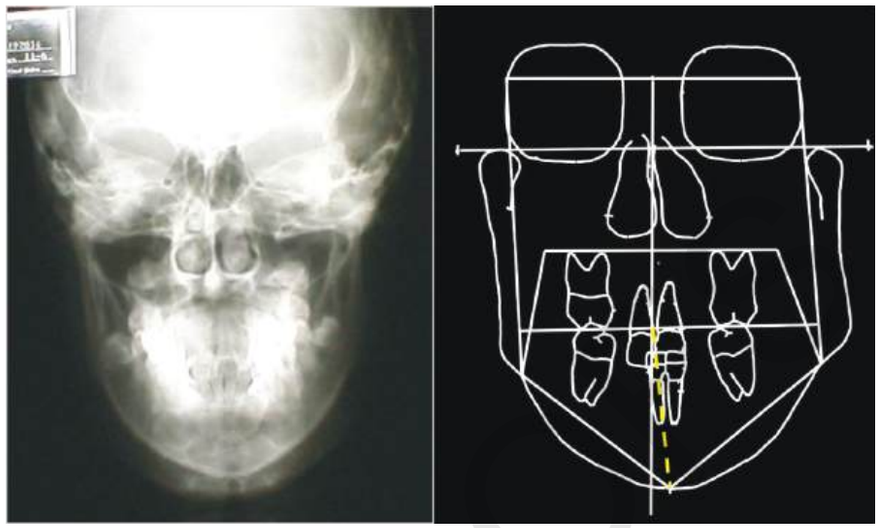

Figure 11.2.9 Frontal cephalometric evaluation.

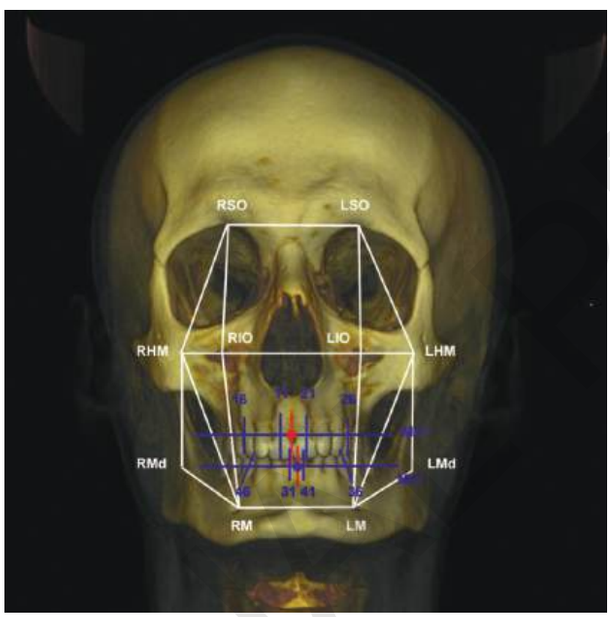

Figure 11.2.10 3D cephalometric analysis.

structures being equidistant from the film and X-ray source. Hence, landmarks on either side of the midline can be measured and contrasted with greater accuracy (Figure 11.2.9).

With the development and subsequent popularization of CBCT, 2D radiographs, especially when facial asymmetry is involved, have largely become redundant. Faure et al. (2013) have conceived a useful analysis when investigating and measuring asymmetry using CBCT volumes (Figure 11.2.10). While the hard tissue analysis is important and requires a comprehensive work-up, the soft tissue is actually of greater importance. Even if the hard tissue is significantly asymmetric, if the soft tissue is favorable and camouflages the asymmetry, then skeletal correction may not be required, and dental compensation could be performed.

Management of Posterior Dental Asymmetries

Occlusal Plane

One of the most common sources of occlusal asymmetry is the mesial-in rotation of the maxillary first molars (Figure 11.2.11). When this is present, the most effective method of dealing with the asymmetry is the transpalatal arch (TPA), which is activated to derotate the offending tooth, and hence also has a distalizing reaction force on the contralateral molar (Nanda and Margolis 1996). Figure 11.2.12

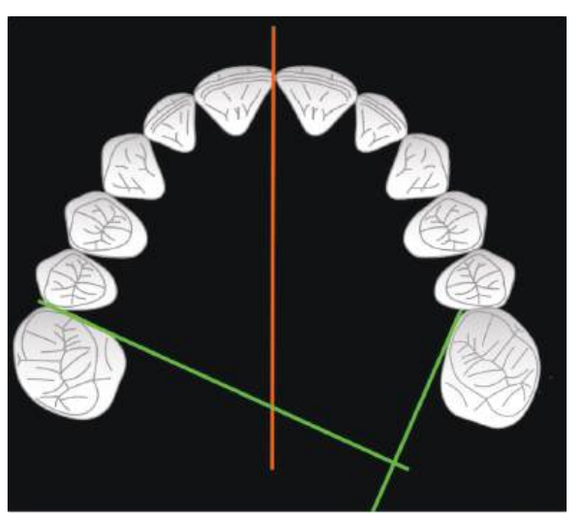

Figure 11.2.11 Occlusal asymmetry with mesial-in rotation of the maxillary first molar.

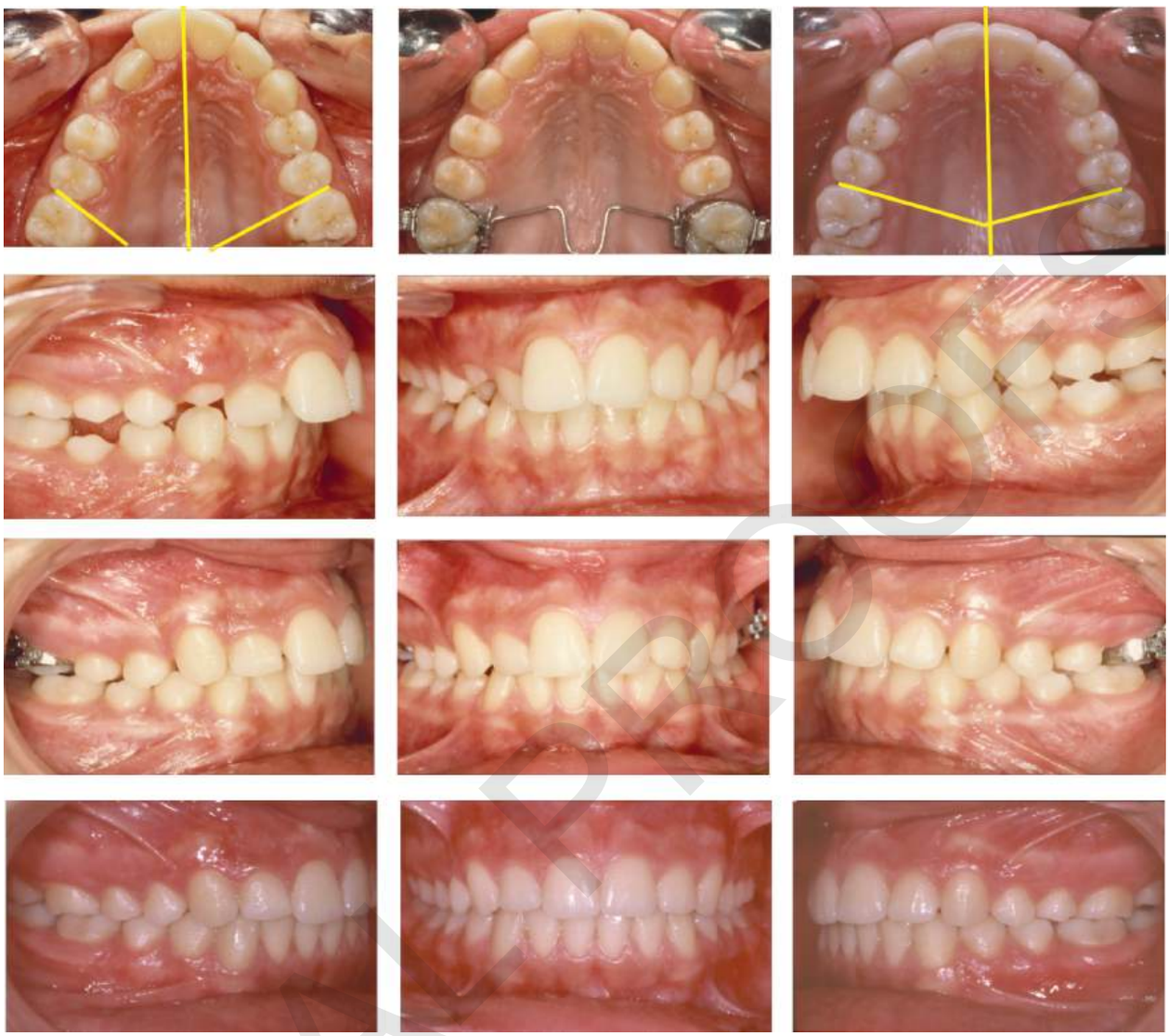

Figure 11.2.12 A Class II malocclusion case in which the upper first molars were rotated mesially in. The first molars were derotated using a TPA and headgear.

shows a Class II malocclusion case in which the upper first molars were rotated mesially in. The first molars were then derotated using a TPA and headgear, thus also aiding Class II correction.

Sagittal Plane

Molar Tipping

Tipping of the maxillary molar is another common problem associated with the early exfoliation of the primary second molar (Figure 11.2.13). In the mixed dentition, both fixed and removable appliances can be used to tip back the molar and regain space (Figure 11.2.14). Extra-oral anchorage is

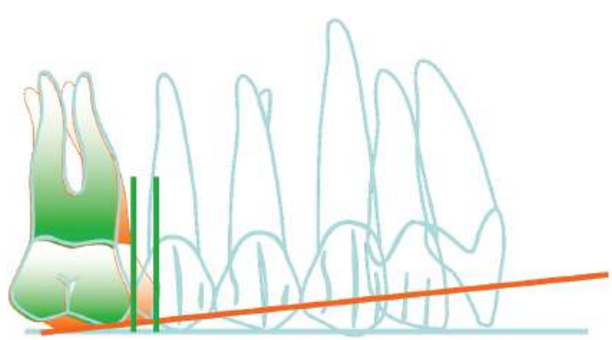

Figure 11.2.13 Tipping of the maxillary first molar is a common problem associated with the early exfoliation of the primary second molar.

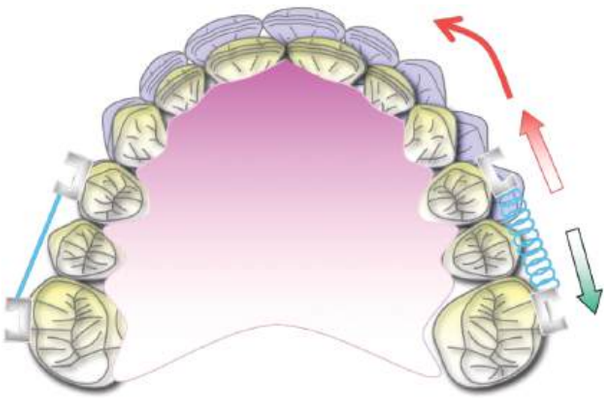

Figure 11.2.14 Orthodontic appliances are used to tip back the molar and regain space.

particularly useful to prevent unwanted proclination due to the side effects caused by the appliances. Figures 11.2.15 and 11.2.16 display a case in which an upper removable appliance was used in conjunction with a J-hook headgear to distalize the molars and correct the Class II malocclusion while maintaining the anterior anchorage.

Asymmetrical Class II

A Class II subdivision malocclusion occurs in about 3% of Class II malocclusion patients and can be particularly challenging to treat (Kula et al. 1998). In non-extraction cases, unilateral forces are often applied, which leads to inadvertent side effects. In the case of unilateral Class II elastics, this leads to extrusion of the canine area on the Class II side and canting of the occlusal plane (Figure 11.2.17). To mitigate this effect, an opposite force is required. This can be done using a traditional J-hook or TADs (Figure 11.2.18). Figure 11.2.19 exhibits the use of a J-hook headgear in addition to a unilateral Class II elastics on the right side in order to treat the Class II, division 2, subdivision right malocclusion. To avoid the use of Class II elastics entirely, and prevent unwanted deleterious effects of proclining the lower incisors (Balut et al. 2019), en-masse distalization can be performed using TADs or a cervical headgear if indicated (Figure 11.2.20).

Asymmetrical Space Closure

Often times differential space closure is required during treatment in order to center the midline (Figure 11.2.21). Using closing loops and tiebacks, differential anchorage, or through increasing or decreasing the number of anchoraged teeth, can all be utilized to obtain the desired midline correction. Figure 11.2.22 shows a case in which extractions were performed, and the lower space closed asymmetrically in order to align the midlines.

Frontal Plane

The most common asymmetry viewed frontally is unilateral crossbites. Skeletal and dental crossbites can be distinguished based on the inclination of the affected teeth (Figure 11.2.23). If the maxillary teeth are palatally inclined, then the crossbite is usually due to a dental origin. In this case, correction can be done in a variety of ways, including via archwire, elastics, removable appliances, quadhelix, or a combination of thereof.

When the affected maxillary teeth are inclined labially and are in crossbite, then this points toward a skeletal problem, which can be confirmed by an examination of the palatal vault anatomy. If the patient is young enough, a regular rapid palatal expansion (RPE) can be utilized to expand and split the suture. Thereafter, extra labial root torque will be required to correct the inclination of the teeth (Figure 11.2.24). Figure 11.2.25 exhibits a case of maxillary constriction which was treated using an RME followed by conventional fixed appliances. Extra labial root torque was placed during treatment to prevent flaring of the posterior dentition and prevent hanging cusps. If the patient is an adolescent or a young adult, expansion may be performed using miniscrew-assisted rapid palatal expansion (MARPE).

Management of Anterior Dental Asymmetries

Axial Inclination

When a midline deviation is recognized, the face should be assessed for symmetry. If the face is symmetrical, then the midline discrepancy will be of dental origin, and hence treated orthodontically. If the face too is asymmetrical, then orthodontic-surgical correction may be required.

Dental midline deviations may present in a few ways: (i) only the upper midline may be deviated, (ii) only the lower midline is deviated, (iii) upper and lower midlines deviate in opposite directions, and (iv) both upper and lower midlines are deviated in the same direction (Jerrold et al. 1990) (Figure 11.2.26).

The axial inclination of the anterior teeth may also be a cause of midline discrepancy. In order to assess this, the interdental papilla and contact point should be perpendicular to the horizontal plane. If the line between the papilla and contact point is not perpendicular to the horizontal plane, then the incisors are inclined (Figure 11.2.27). Figure 11.2.28 displays the use of extractions and proper bracket positioning to correct the axial inclination of the upper incisors.

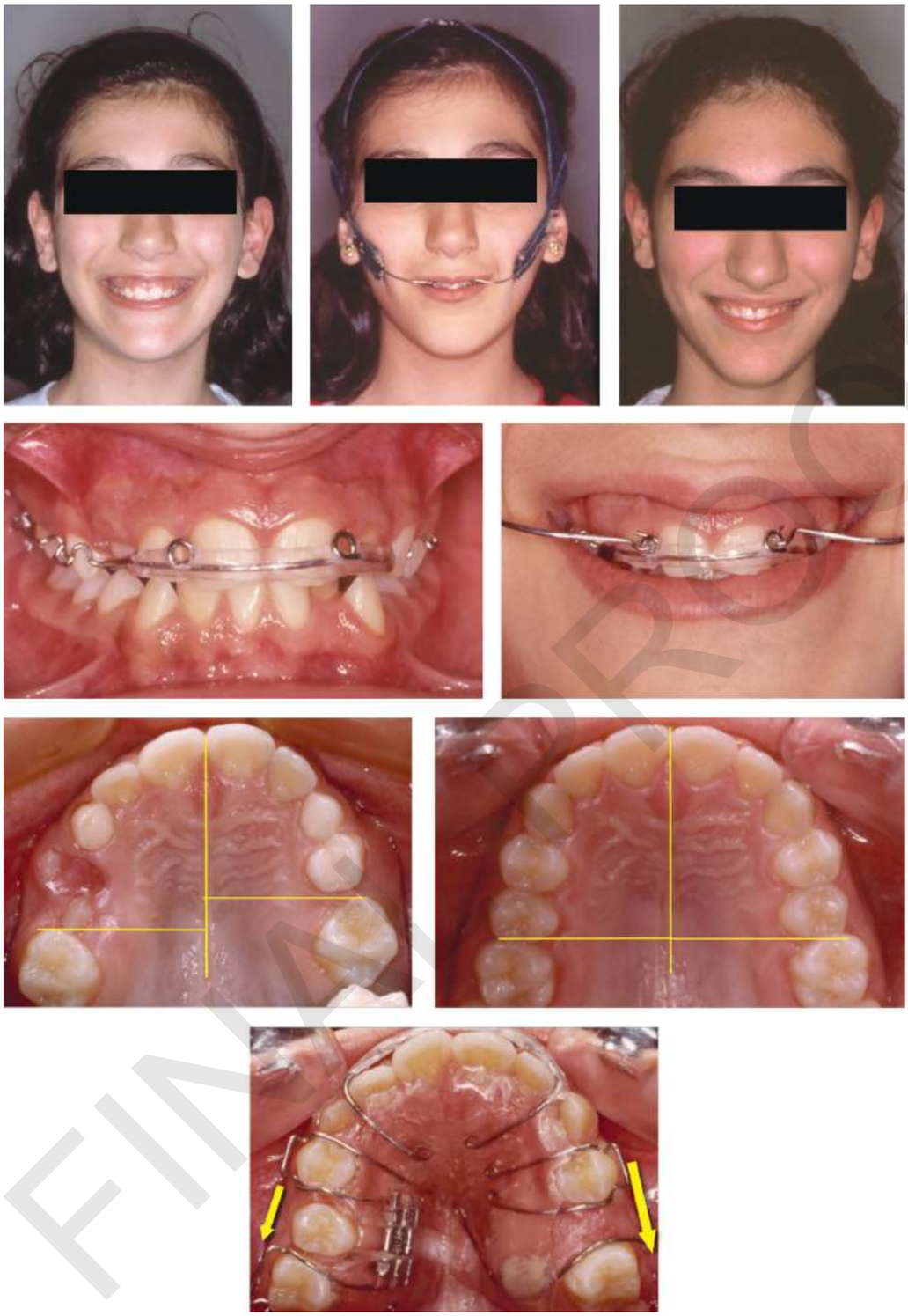

Figure 11.2.15 A case in which an upper removable appliance can be used in conjunction with a J-hook headgear to distalize the molars while maintaining the anterior anchorage.

Figure 11.2.16 Asymmetry management and malocclusion correction.

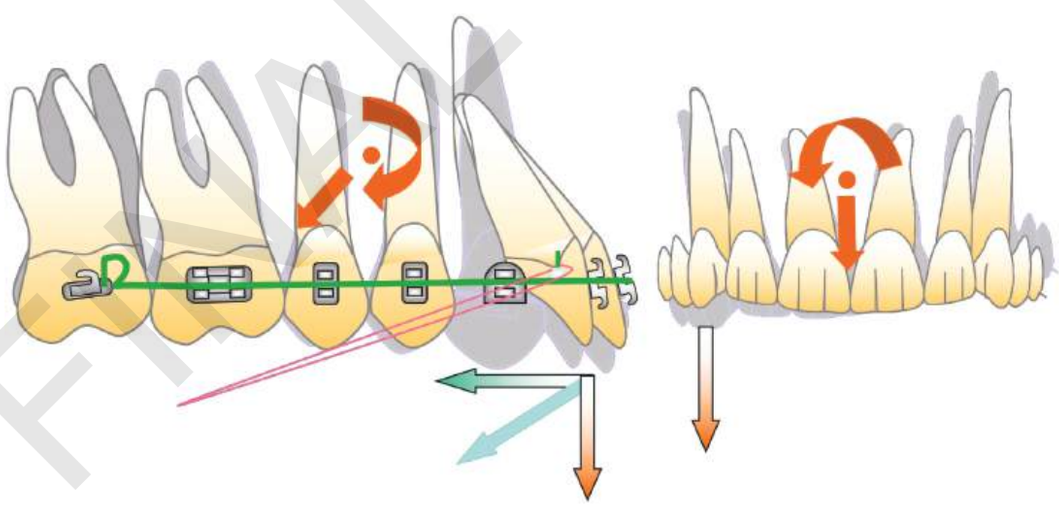

Figure 11.2.17 The use of unilateral Class II elastics may lead to extrusion of the canine area on the Class II side and canting of the occlusal plane.

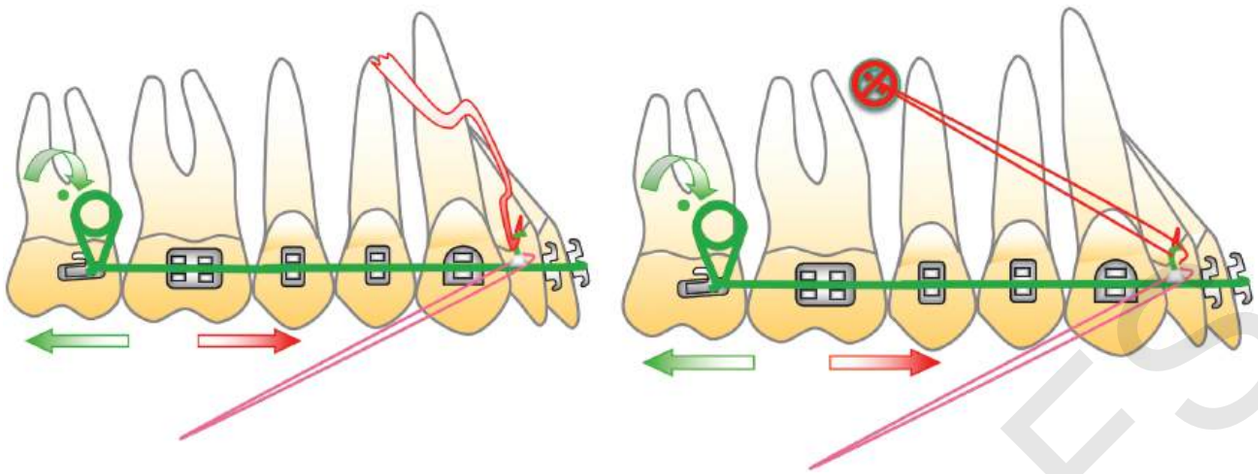

Figure 11.2.18 A traditional J-hook or TAD can be used to mitigate this effect.

Figure 11.2.19 A J-hook headgear is used in addition to a unilateral Class II elastic on the right side to treat the Class II, division 2, subdivision right malocclusion.

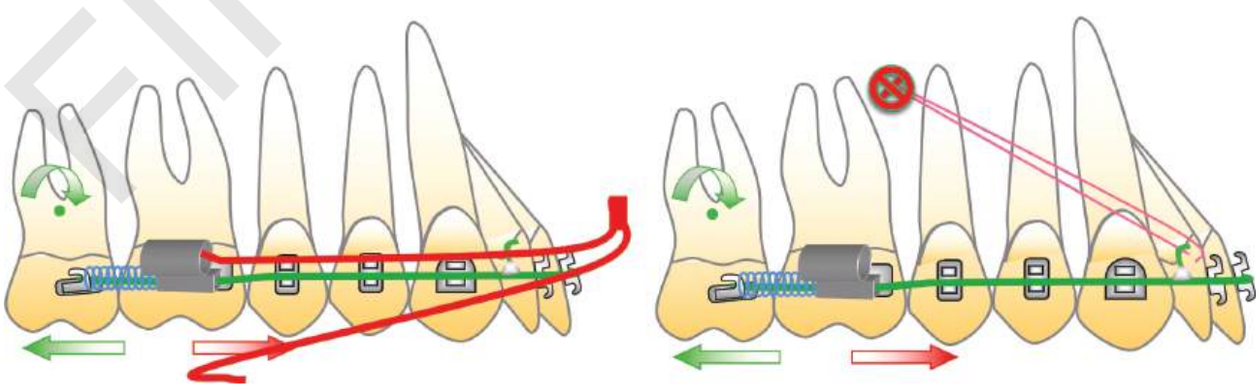

Figure 11.2.20 To avoid Class II elastics use, and prevent proclining the lower incisors, en-masse distalization can be performed using TADs or a cervical headgear if indicated.

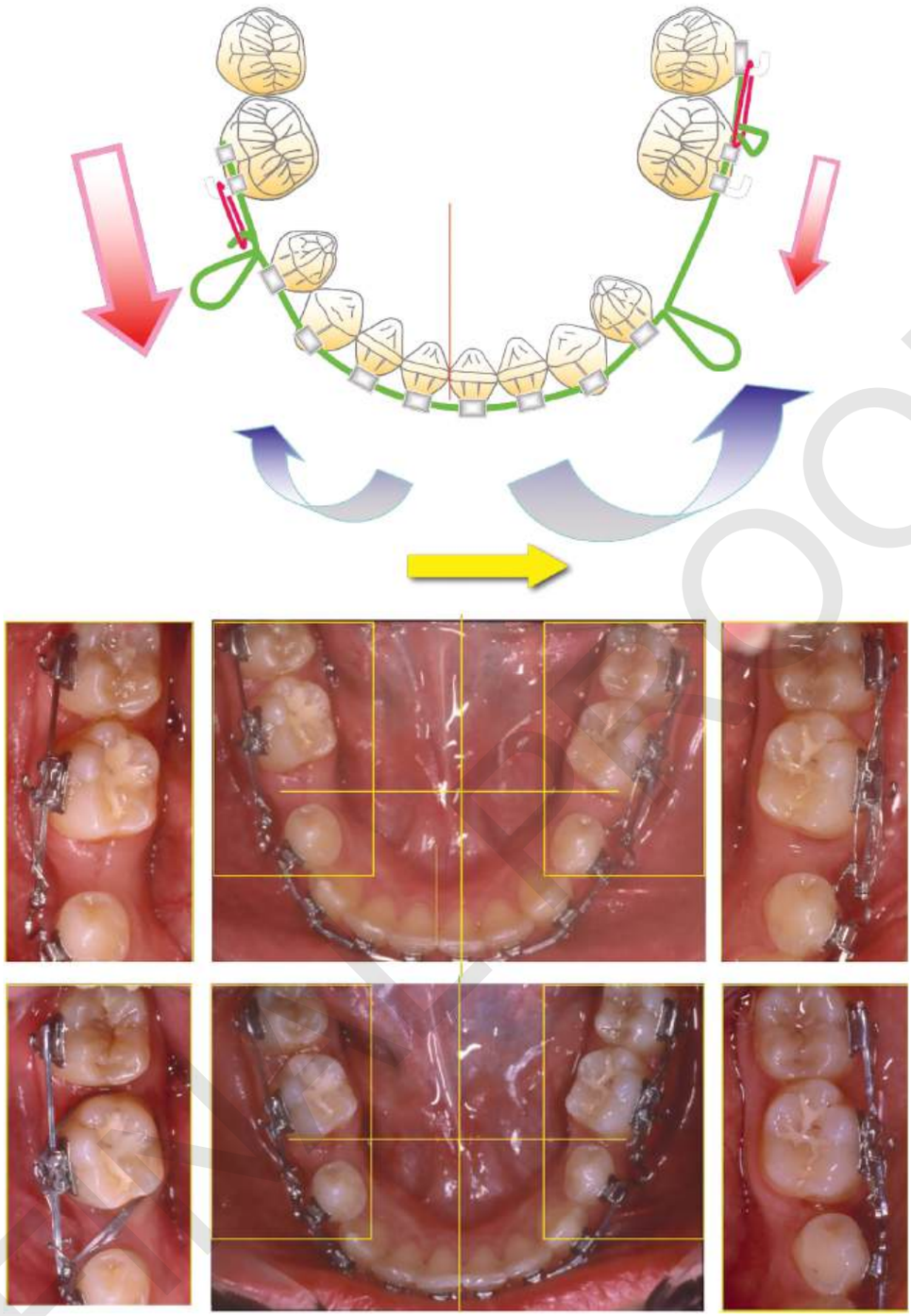

Figure 11.2.21 Space closure management using closing loops, tiebacks, and differential anchorage to obtain the desired midline correction.

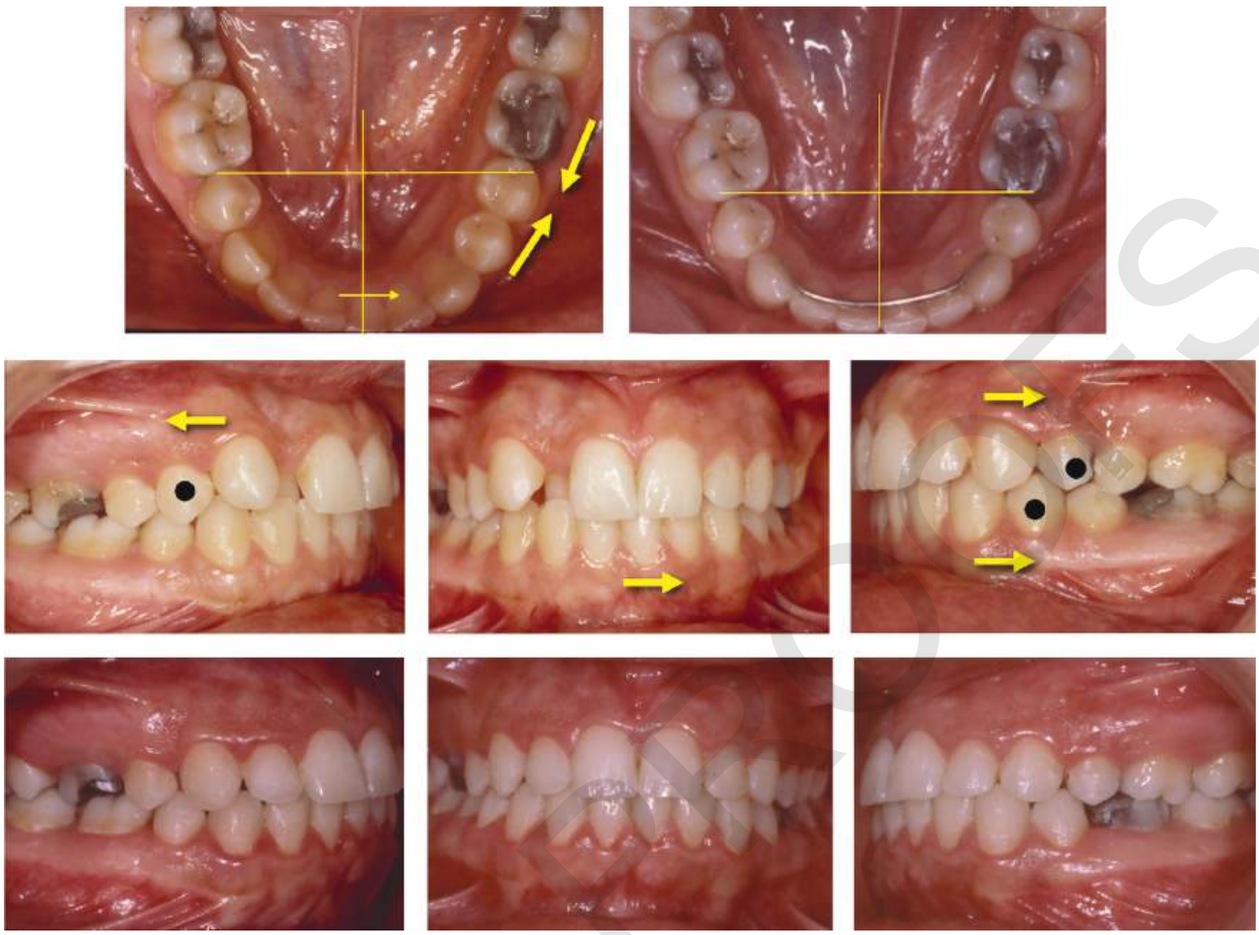

Figure 11.2.22 A case in which extractions were performed, and the lower space closed asymmetrically in order to align the midlines.

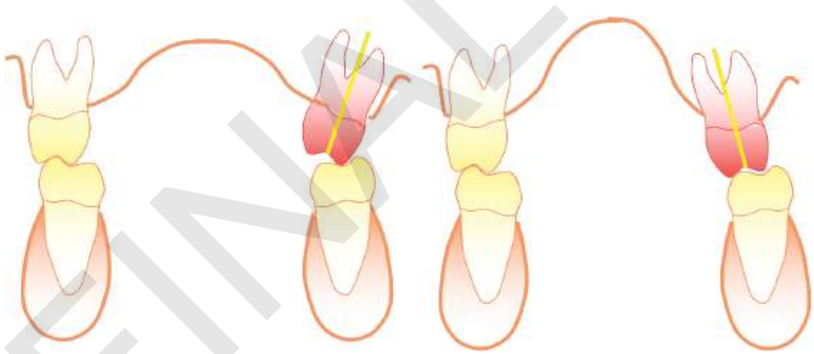

Figure 11.2.23 Skeletal and dental crossbites can be distinguished based on the inclination of the affected teeth.

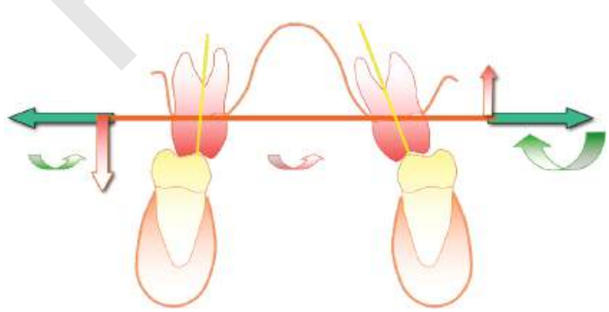

Figure 11.2.24 Rapid palatal expansion can be utilized to expand and split the suture. Extra labial root torque will be required to correct the inclination of the teeth.

Figure 11.2.25 A case of maxillary constriction treated using rapid palatal expansion followed by conventional fixed appliances: Extra labial root torque was placed on the upper lateral segments to prevent flaring and hanging cusps.

Figure 11.2.26 Dental midline deviations may present in a few ways: (1) only the upper midline may be deviated, (2) only the lower midline is deviated, (3) upper and lower midlines deviate in opposite directions, and (4) both upper and lower midlines are deviated in the same direction.

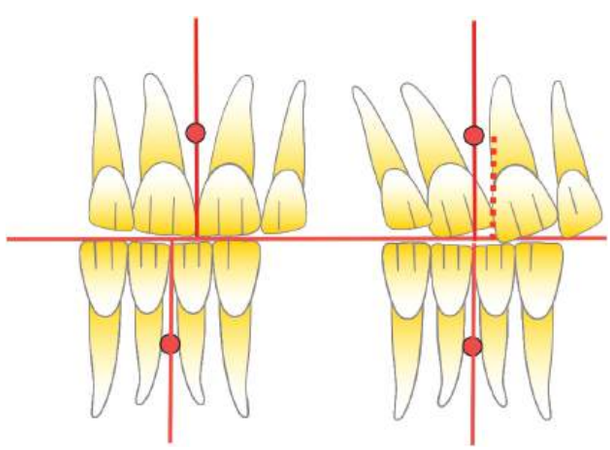

Figure 11.2.27 The axial inclination of the anterior teeth may also be a cause of midline discrepancy. The interdental papilla and contact point should be perpendicular to the horizontal plane.

Figure 11.2.28 The use of extractions and proper bracket positioning to correct the axial inclination of the upper incisors is shown.

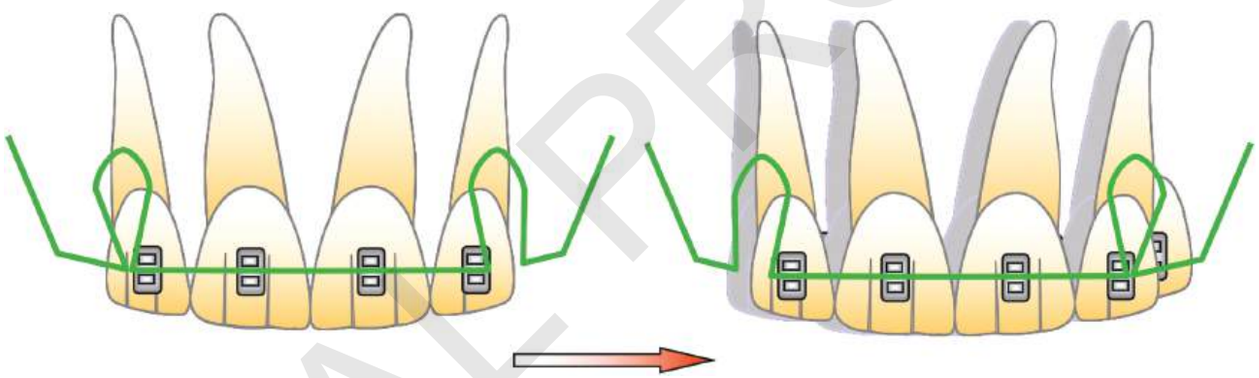

Figure 11.2.29 Asymmetrical space closure using closing loops is an excellent way of correcting midline discrepancies.

Closing Loops on a Continuous Archwire

Asymmetrical space closure using closing loops is an excellent way of correcting midline discrepancies (Jerrold et al. 1990). The loops should be close to the lateral incisor bracket, and the unilateral activation should be gentle (Figure 11.2.29). Figure 11.2.30 shows a patient in which asymmetrical space closure was used to center the upper midline after extraction of four premolars.

Asymmetrical Directional Forces

Asymmetric mechanics are required to treat asymmetrical problems, such as midline deviations and occlusal plane cants (Figure 11.2.31). These mechanics should not utilize the dentition for anchorage, as the reaction forces may cause undesired side effects. Hence, extra-oral anchorage such as J-hooks and headgears, or bone-borne anchorage such as TADs are preferable (Figure 11.2.32). Figure 11.2.33 shows the asymmetrical use of J-hooks in the first and third quadrants. The J-hook attached to the first quadrant was used for distalizing the dentition and correcting the Class II malocclusion and upper midline deviation. The J-hook in the third quadrant was used to extrude the lower left anterior segment, thus correcting the lower anterior cant.

Tooth-by-Tooth Movement

When correcting midline deviations, it is prudent to close the space strategically in order to make the treatment efficient. Uncontrolled space closure can cause anchorage loss

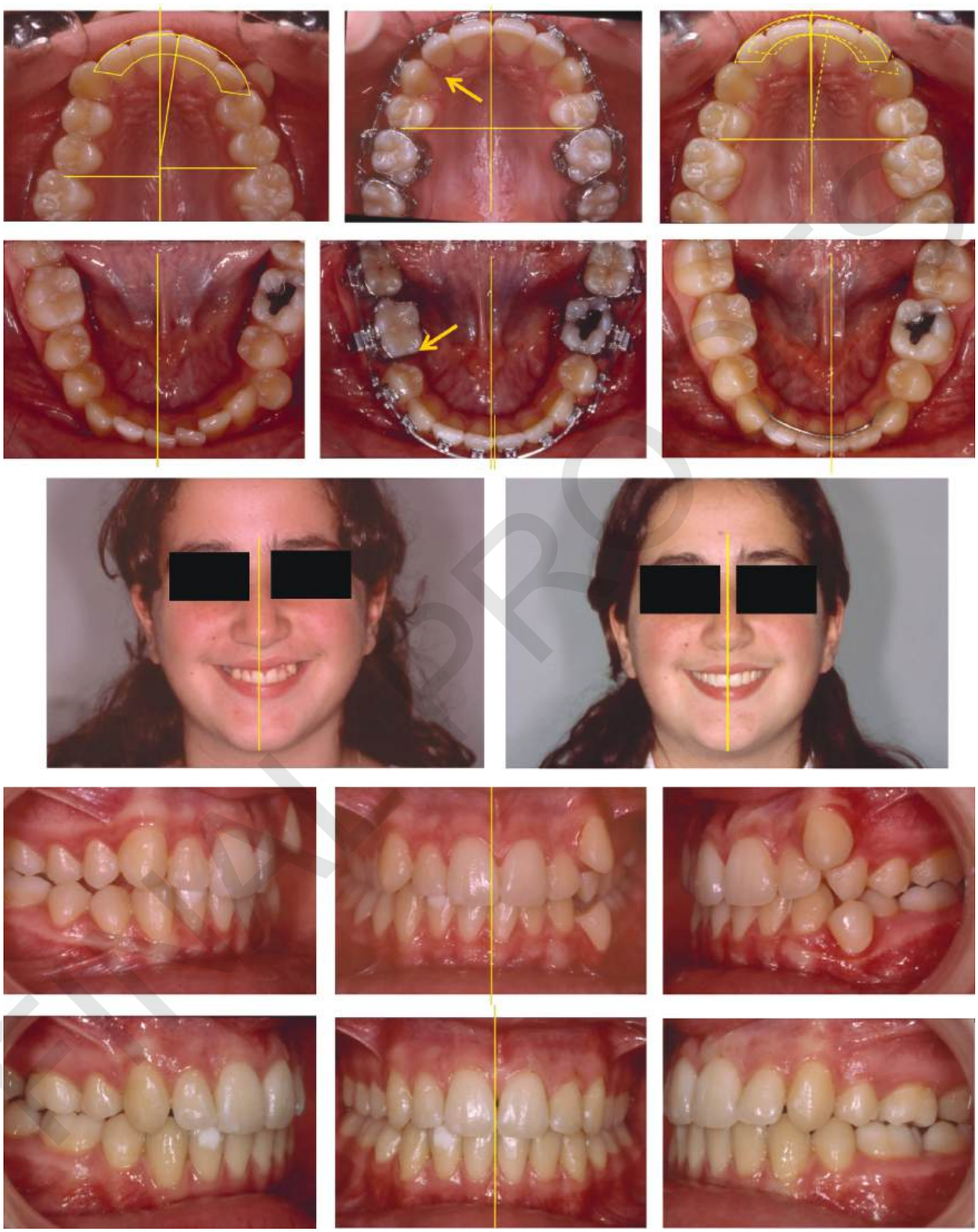

Figure 11.2.30 A patient in which asymmetrical space closure was used to center the upper midline after extraction of four premolars.

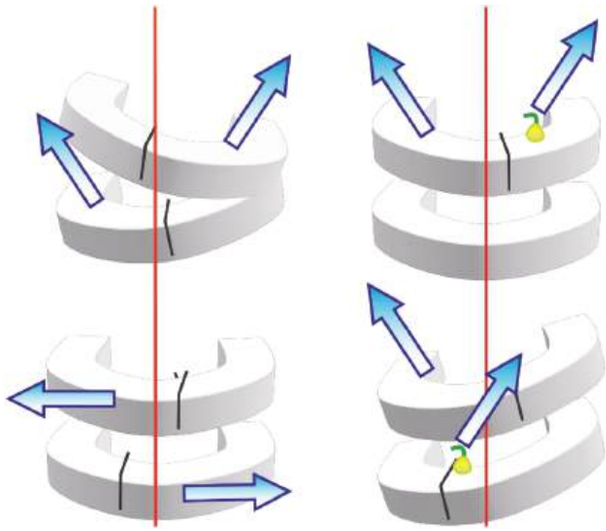

Figure 11.2.31 Asymmetric mechanics are required to treat asymmetrical problems, such as midline deviations and occlusal plane cants.

Figure 11.2.32 A case in which TADs were used to correct upper midline deviation and control anchorage.

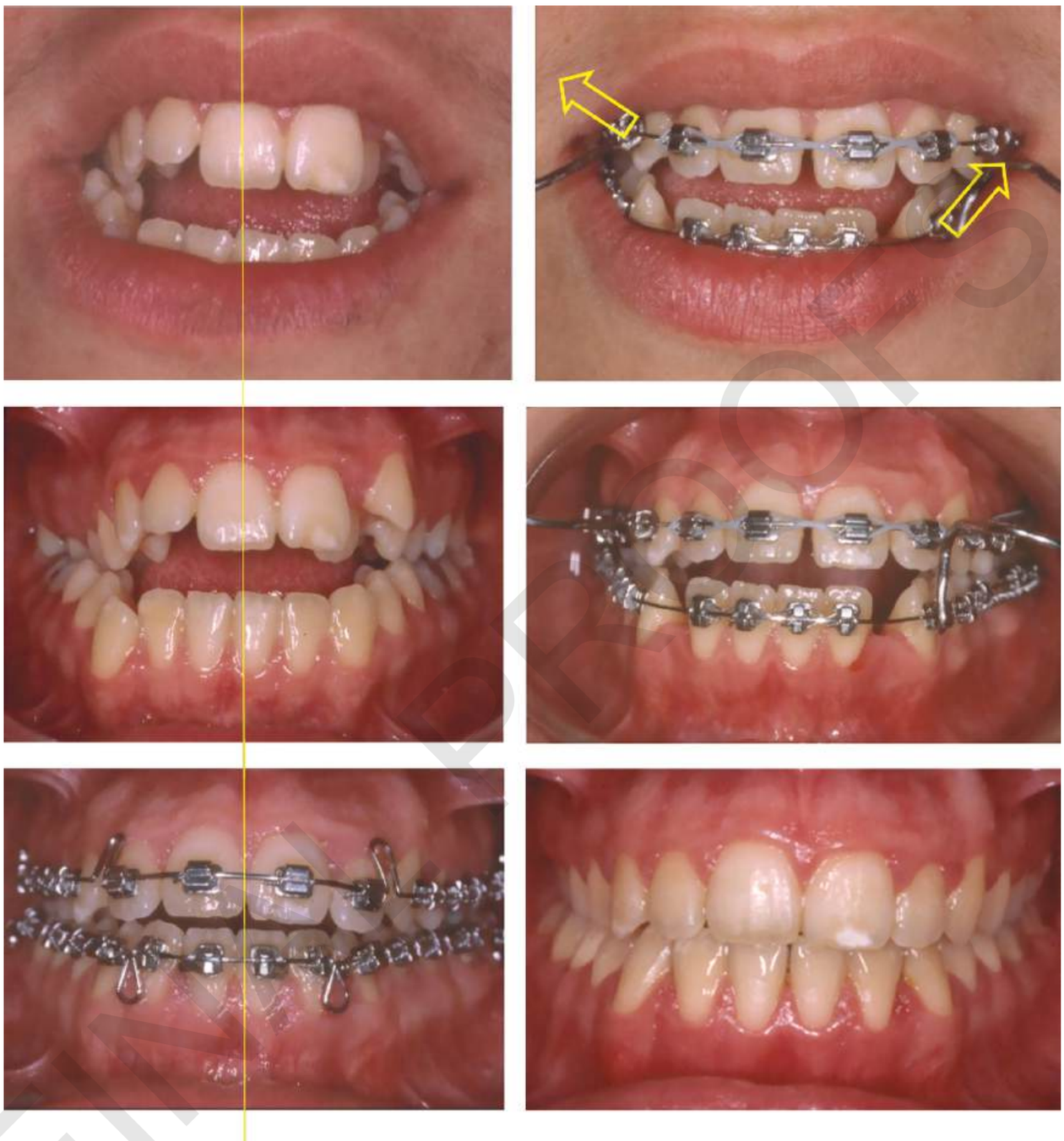

Figure 11.2.33 Asymmetrical use of J-hooks for malocclusion management, midline deviation, and occlusal plane cant correction.

and the extraction spaces may close without resolving the problem. Thus use of oblique anterior intermaxillary elastics may be required, which may produce side effects such as an anterior occlusal plane cant and asymmetric smile. Moving each tooth separately using sequentially activated open coil springs and powerchains, and using figure 8's on the anchor units, is an effective way to center the midlines during space closure (Figure 11.2.34).

Anterior Rotational Control

A canted occlusal plane is a complicated orthodontic problem. Traditionally treated with orthognathic surgery, occlusal cants have more recently been corrected using TADs for less invasive treatment. Appliances such as J-hooks, asymmetric auxiliary arches, or cantilevers with sectional mechanics can also be utilized

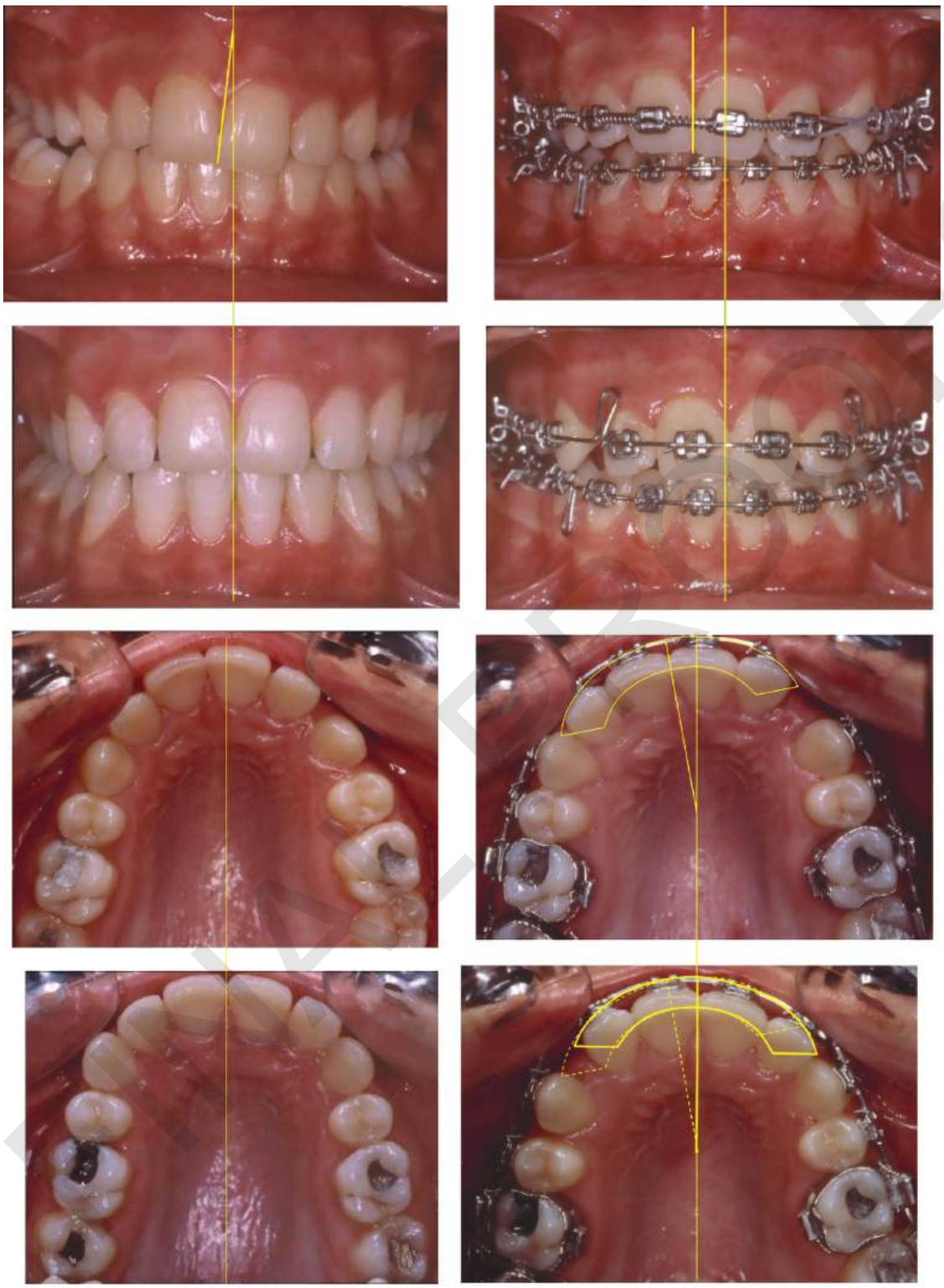

Figure 11.2.34 Moving each tooth separately, using sequentially activated open coil springs and powerchains, to center the midlines.

(van Steenbergen and Nanda 1995). These asymmetric mechanics allow for the intrusion of one side and extrusion of the other. The reaction forces are mitigated by using a TPA (Figure 11.2.35).

A novel method is the "Yin-Yang" archwire, described by Liou et al. (2019), which is a continuous archwire that is ligated conventionally to each bracket. It essentially consists of a curve of Spee (CoS) on one side of the archwire and reverse CoS (RCoS) on the other using a rectangular TMA archwire (Hansa et al. 2020) (Figure 11.2.36).

Asymmetrical Extractions

When a patient presents with a symmetric face but with deviated midlines and extractions are warranted, asymmetric extraction patterns are a great way to facilitate mechanics, make treatment more efficient, and decrease treatment duration (Nanda and Margolis 1996).

Depending on the molar and canine relationship and the distribution of crowding, asymmetric extraction patterns could include unilateral extractions or dissimilar teeth

Figure 11.2.35 A case where asymmetrical rotational control is applied to correct the cant of the anterior occlusal plane.

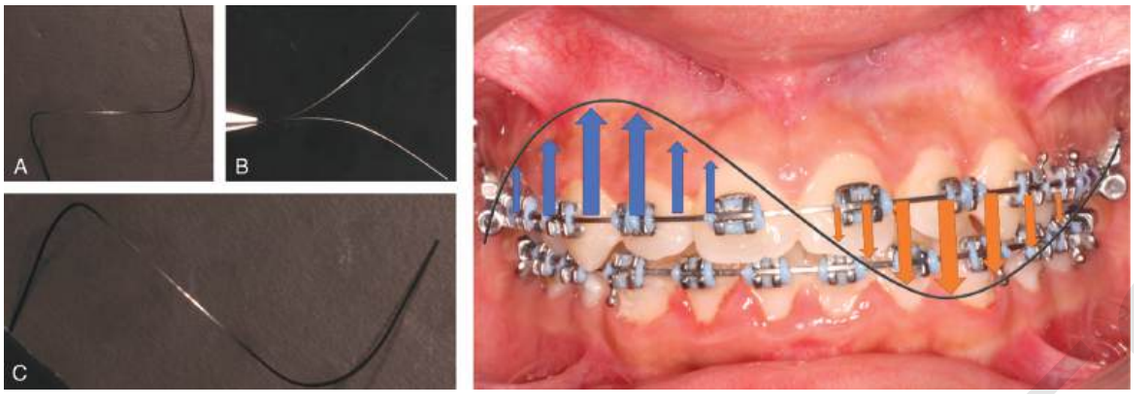

Figure 11.2.36 The "Yin-Yang" archwire consists of a curve of Spee on one side of the archwire and reverse curve of Spee on the other, using a rectangular TMA archwire.

Figure 11.2.37 A case in which asymmetrical extractions were performed to correct midline deviation.

being extracted in the four quadrants (Janson et al. 2003). Figure 11.2.37 shows such a case in which the upper midline was deviated to the left. As extractions were warranted, the decision was made to extract the upper right first premolar and the upper left second premolar, in addition to the lower second premolars in order to aid midline correction.

Conclusions

In summary, the treatment of dental asymmetries requires a comprehensive 3D investigation in order to obtain an accurate diagnosis. Once the diagnosis is determined, treatment planning in all three dimensions should be performed and individualized. Dental asymmetries should ideally be treated using dental movements, functional asymmetries addressed with interarch controlled mechanics, and skeletal asymmetries resolved with orthognathic surgery.

Acknowledgment

The authors would like to thank Dr. Elie El Amm for the graphic illustrations.

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