บทความปริทัศน์
Review Article

การดึงยางแบบที่ III: แบบดั้งเดิม และการประยุกต์ใช้

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บทคัดย่อ

การดึงยางแบบที่ III เป็นการดึงยางจากฟันเขี้ยวล่างไปยังฟันกรามบน ทำให้เกิดการเคลื่อนของฟันบนไปด้านหน้า และฟันล่างเคลื่อนไปด้านหลัง การดึงยางแบบที่ III นี้ใช้ประโยชน์ได้ในหลายกรณี เช่น ในการจัดฟันเพื่ออำพรางความผิดปกติของโครงสร้างขากรรไกรแบบที่ III, ในการกระตุ้นการเจริญเติบโตของขากรรไกรบน ในผู้ป่วยที่มีโครงสร้างขากรรไกรแบบที่ III เนื่องจากขากรรไกรบนมีขนาดเล็ก และการเสริมหลักยึดสำหรับการเคลื่อนฟันในหลายๆ กรณี อย่างไรก็ตาม การดึงยางแบบนี้อาจส่งผลข้างเคียงที่ไม่พึงปรารถนา เช่น การเคลื่อนฟันตัดบนออกไปด้านหน้า การเคลื่อนฟันตัดล่างเข้าไปด้านหลัง รวมทั้งการหมุนของขากรรไกรล่างตามเข็มนาฬิกา จากการยื่นยาวของฟันกรามบน ซึ่งจะส่งผลเสียทั้งในด้านความสวยงาม และการคงสภาพฟัน โดยเฉพาะอย่างยิ่งในผู้ที่มีใบหน้ายาว จึงมีการประยุกต์การดึงยางแบบที่ III นี้ในรูปแบบต่างๆ หรือใช้ร่วมกับเครื่องมืออื่นๆ เพื่อลดผลข้างเคียงดังกล่าว เช่น การใช้ร่วมกับลวดโค้งข้ามเพดาน แนนซ์ ลิงกัว อาร์ช การปรับเปลี่ยนแบร็คเก็ต การดัดลวดชนิดต่างๆ เครื่องมือนอกช่องปาก และเครื่องมือหลักยึดชั่วคราว

คำสำคัญ: การเสริมหลักยึด, การจัดฟันเพื่ออำพรางความผิดปกติ, ยางจัดฟันแบบที่ III, การกระตุ้นการเจริญเติบโตของขากรรไกรบน

Class III elastic traction: classical and modified design

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Abstract

Class III elastic traction is an inter-maxillary traction from the lower canine region to the molar region of the upper arch. This moves upper teeth forward and lower teeth backward. Class III elastic traction is utilized in several situations such as, camouflage treatment in non-growing Class III patients, a maxillary orthopedic protraction in skeletal Class III patients with maxillary deficiency and an anchorage reinforcement. There are 2 types of Class III elastic traction's design 1). Classical design and 2). Triangular Class III elastic traction, with or without upper lateral incisors engaged. This literature review presents various applications as follows 1). Class III elastic traction with accentuated curve of Spee archwires, 2). Class III elastic traction in

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multi-loop edgewise archwire appliance, 3). Class III elastic traction with headgear for lower arch retraction, 4). Class III elastic traction with temporary anchorage devices, and 5). Class III elastic traction with bone-anchoraged maxillary protraction. However, Class III elastic traction may result in undesirable side effects such as proclination of the maxillary incisors, retroclination of the mandibular incisors and upper molar extrusion. These side effects can cause the clockwise rotation of the mandible, which may result in many problems of dentofacial esthetics and stability, especially in the long face patients. To minimize these undesirable side effects, the modified design and several techniques such as transpalatal arch, Nance lingual arch, modified bracket system, modified arch wire, multi-loop edgewise archwire, extra-oral appliance, and temporary anchorage devices have been proposed to be used in combination with Class III elastic traction.

Keywords: anchorage reinforcement, camouflage treatment, class III elastic, maxillary protraction

Introduction

Class III elastic traction is an inter-maxillary traction that uses the force from elastic loop connected between the maxillary and mandibular arches, to move the teeth of upper and lower arch reciprocally or using the teeth in one arch as anchorage for tooth movements in the opposite arch. In the classical design, the direction of Class III traction is from the lower canine region to the upper molar region. This moves upper teeth forward and lower teeth backward. As a general rule, Class III elastic traction is used in the treatment of Class III malocclusion. With respect to anchorage, Class III elastic traction is commonly used to reinforce the anchorage by using the tooth from one arch to help produce desired tooth movement in the opposite arch. Moreover, in the cases that intra-oral anchorage is insufficient to carry out the desired tooth movements, Class III elastic traction in combination with extra-oral head gear force to the upper molar can be used to reinforce extra-oral anchorage. However, Class III elastic traction may result in some undesirable side effects such as proclination of the maxillary incisors, retroclination of the mandibular incisors, and upper molar extrusion, and this causes clockwise rotation of the mandible. These changes may cause the problems of dentofacial esthetics and also the stability, especially in the long face patients. To minimize these undesirable side effects, the modified design and several techniques such as the transpalatal arch, Nance lingual arch, modified bracket systems, modified arch wire, multi-loop edgewise archwire (MEAW), extra-oral appliance, and temporary anchorage devices (TADs) have been proposed to be used in conjunction with Class III elastic traction. In addition, Class III elastic traction can be modified to use with skeletal anchorages to protract the maxilla in the growing patient who has skeletal Class III relation with maxillary deficiency.[1]

Design of class III elastic traction

1. Classical design of class III elastic traction

The classical design of Class III elastic traction starts from the lower canine and goes to the upper first molar (Fig. 1). This force direction causes forward movement of upper teeth and backward movement of lower teeth. In the upper arch, it moves the posterior teeth forward to close the space and/or proclines the upper incisors along with the mesialization of the whole arch. The classical design can be modified in order to create a desired component of the force. It can go to the upper second molar as the more horizontal

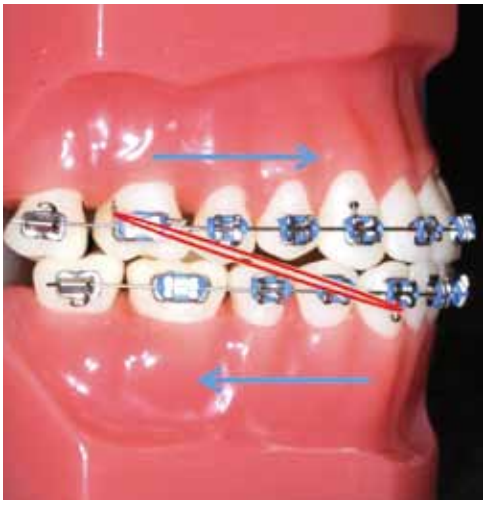

Fig. 1 The classical design of Class III elastic traction

Fig. 2 Triangular Class III elastic traction

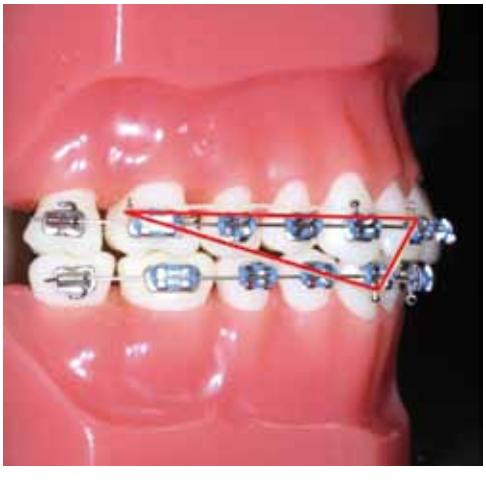

Fig. 3 Triangular Class III elastic traction that attach to the upper lateral incisors to extrude upper anterior teeth for closing the bite in the anterior region.

component of force is required. In the other hand, it can go to the upper first or second premolar, in the term of short Class III elastic, as the more vertical component of force is required in order to minimize the extrusive effect on the back of the arches especially in the anterior open bite cases.[2]

2. Triangular Class III elastic traction

Like the classical design of Class III elastic traction, this triangular Class III elastic traction starts from the lower canine. It also attaches to the upper canine or bicuspid along with the upper first or second molar forming a triangle (Fig. 2). This triangular Class III traction moves upper teeth forward and lower teeth backward and also has the vertical component of force that brings the posterior teeth together. Moreover, Class III elastic traction tends to extrude molars, leading to development of anterior open bite. In the patient that some elongation of the molars and incisors is desirable, this Class III elastic traction may attach to the upper lateral incisors forming triangle that has the vertical component of force to extrude upper anterior teeth for closing the bite in the anterior region (Fig. 3).[3]

Applications of Class III elastic traction

There are many applications of Class III elastic traction such as 1). a camouflage treatment in non-growing Class III patients, 2). in growth modification (a maxillary orthopedic protraction in skeletal Class III patients with maxillary deficiency), and 3). an anchorage reinforcement in the other situations.

1. Class III elastic traction as a camouflage treatment in non-growing Class III patients

Class III elastic traction is most helpful in non-surgical orthodontic correction of Class III malocclusion. It favours proclination of upper incisors along with mesialization of the whole arch, simultaneously retroclination of lower incisors and distalization of lower arch. All force components of the Class III elastic traction can be helpful in reaching treatment goals in average or low angle cases. However, in high angle Class III cases with an open

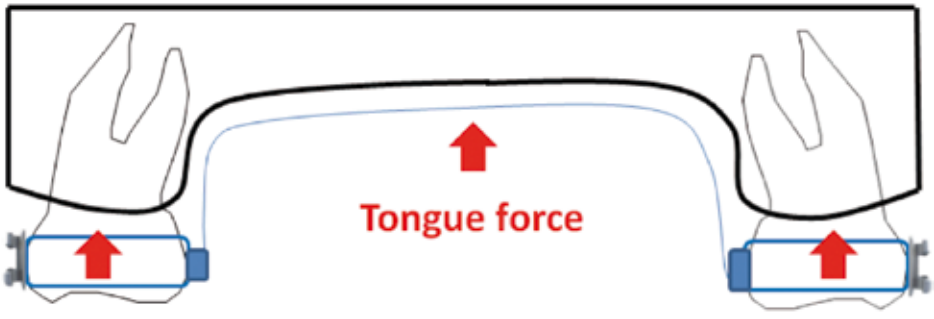

Fig. 4 Tongue forces can assist in vertical control of the upper molars when palatal bar is placed 2 mm away from the palate.

bite tendency, the vertical force components may have undesirable side effects that cause extrusion of the upper molars which rotates the occlusal plane posterior, and this results in the clockwise rotation of the mandible leading to a decrease of overbite as well as an increase of lower face height. Other undesirable side effect of Class III elastic traction is that it may cause labial proclination of the upper anterior teeth and lingual retroclination of the lower anterior teeth. These changes may compromise the profile esthetic outcome and stability of the treatment, especially in patients with long face.[4]

To provide appropriate treatment outcome and reduce these adverse effects, several techniques such as transpalatal arch, Nance lingual arch, modified bracket systems, modified arch wire, multi-loop edgewise archwire, extra-oral appliance, and temporary anchorage devices have been used in association with Class III elastic traction in the treatment of patients with skeletal Class III relation.

To minimize the upper molar extrusion in high angle class III cases with an open bite tendency, transpalatal arch that is placed 2 mm away from the palate can be used so that the tongue can exert a vertical intrusive effect. This can counteract with the side effect of Class III elastic traction (Fig. 4).[2]

Nance lingual arch together with 1/4 inch medium force of Class III elastic traction from the upper first molars and hooks that are soldered between lower canines and lateral incisors has been used to control anchorage during retraction of lower anterior teeth into extraction space with sliding mechanics for compensatory orthodontic treatment in patient with skeletal Class III malocclusion with an anterior crossbite. The satisfactory treatment results, ideal overjet and overbite, and eight years stability after treatment were reported.[5]

Self-ligating bracket system on the maxillary arch with Class III elastic traction has been proposed as the compensatory treatment of the Class III malocclusion. Enhanced treatment results are due to greater expansive and protrusive tooth movement than the conventional bracket systems. The decrease of treatment time and the increase of compensatory tooth movement in adult Class III patients have been reported with this approach.[6]

The use of modified arch wire with an accentuated curve of Spee in the upper arch and reverse curve of Spee in the lower arch in association with 150 gram of force per side of Class III elastic traction and 150 gram of force of anterior vertical elastic traction can promote efficient vertical control, with the closure of the anterior open bite due to the clockwise rotation of the upper occlusal plane and due to counter clockwise rotation of the lower occlusal plane (Fig. 5). This technique is appropriate to control vertical

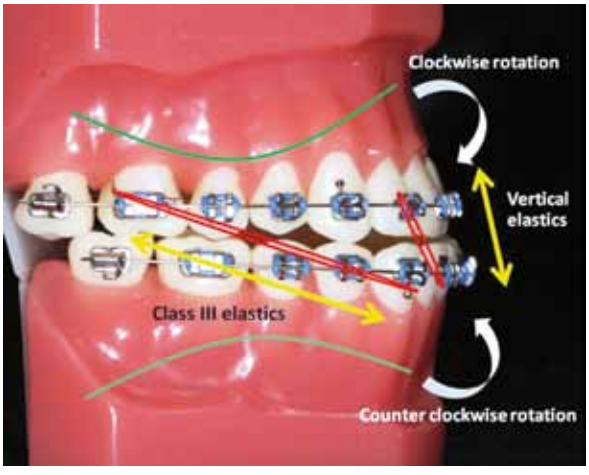

Fig.5 Class III elastic traction associated to an accentuated curve of Spee in the upper arch and reverse curve of Spee in the lower arch, combined with vertical elastics in the anterior region. This technique can close the anterior open bite due to the clockwise rotation of the upper occlusal plane and counter clockwise rotation of the lower occlusal plane.

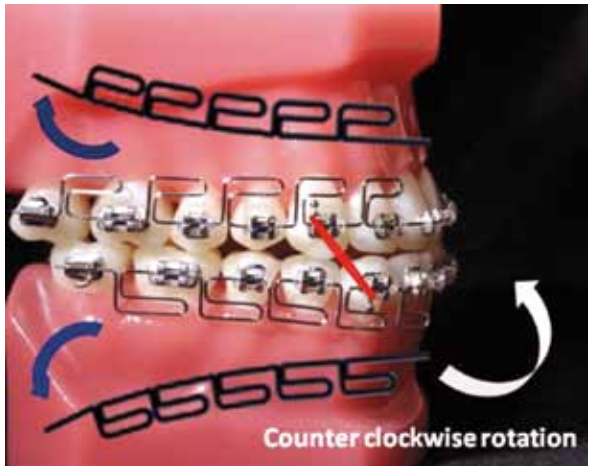

Fig. 6 Multiloop edgewise archwire appliance along with short Class III elastic traction can reconstruct the occlusal plane to a counterclockwise rotation, without significant downward and backward rotation of the mandible.

dimension for hyper-divergent patients with a more balanced facial pattern. Sobral, et al (2013) reported that mandibular plane could be maintained after using this technique, but that a proclination of upper incisors and retroclination of the lower incisors could not be avoided.[7]

Multiloop edgewise archwire had many loops with second-order bend to control the vertical movement of the posterior teeth.[8] The use of multiloop edgewise archwire technique that had progressive tip back bend activation of 3° to 5° from the premolar teeth to molar area along with short Class III elastic traction (3/16 inch, 6 ounce) on the anterior teeth could steepen the upper posterior occlusal plane, and could upright the inclination of the lower teeth, so the entire mandibular arch could be distalized. These effects reconstructed the occlusal plane to a counterclockwise rotation, without significant downward and backward rotation of the mandible (Fig. 6).[9] This technique was suitable for patients with long face and an open bite tendency. However, it might result in flaring and extrusion of the upper incisors. The excessive proclination of the maxillary incisors that compromised the pleasing smile was reported after treatment with multiloop edgewise archwire and short Class III elastic traction.[10] In addition, it greatly depended on patient compliance and the open bite could become worse without patient cooperation wearing elastic traction.

Several alternatives to class III elastic traction have been suggested. To minimize the above adverse effects during en-mass distalization of the mandibular dentition, the application of mini-screws in the posterior area of the mandible as anchorage to distalize and retract the lower teeth using 300-gram forces of nickel-titanium coil springs on each side was a better approach.[10] In addition, extra-oral appliances such as 150 gram of force per side of high-pull J hook head gear to the lower arch with the Class III direction of force at least 12 hours per day had been used instead of Class III elastic traction in order to promote efficient vertical control during treatment, specifically during

lower canine and incisor retraction (Fig. 7).[7] Due to the high pull vector, it promoted efficient vertical control, generating a counterclockwise rotation of the lower occlusal plane, which was favorable for the closure of the open bite. Moreover, the J hook headgear promoted the distal tipping of the terminal molars, prepared mandibular anchorage, and eliminated intrusive forces on the incisors.[11] The significant improvement on the inter-incisal relations without proclination and extrusion of upper anterior teeth was reported after using this technique.[7] The use of this apparatus was possibly an alternative to the use of Class III elastic traction for treating Class III malocclusion.

Nowadays, TADs placed in upper posterior region had been used in combination with 150 gram of force per side of Class III elastic traction function similar to high-pull headgear. Maxillary TADs could prevent undesirable extrusion of the upper molars and proclination of the upper incisors as a counteraction of Class III elastic traction when the upper dentition was used as the anchorage unit to move the lower dentition distally (Fig. 8).[7, 12-13] These temporary anchorage devices simplify the treatment mechanics, reduce the amount of archwire bending, and minimize the anchorage loss. Moreover, maxillary mini-implant could be used in combination with multiloop edgewise archwire and Class III elastic traction (5/16 inch, 3.5 ounce) to provide an appropriate treatment strategy especially for patients with hyper-divergent pattern and open bite tendency. This technique could effectively tip the mandibular molars distally without any extrusion and tip the lower incisors lingually. He, et al (2013) reported that there was no extrusion of upper molars or any clockwise rotation of mandible, and that the upper incisors were not further proclined and patients had no gummy smile after the treatment.[14]

2. Class III elastic traction in growth modification

Maxillary orthopedic protraction is indicated for skeletal Class III young patients with maxillary deficiency. The treatment should begin during

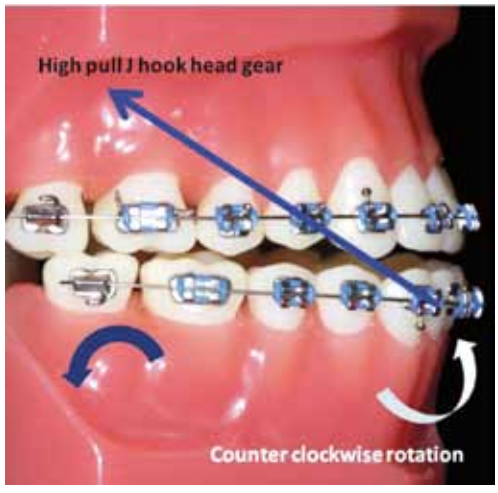

Fig. 7 High-pull J hook headgear to the lower arch can generate a counterclockwise rotation of the lower occlusal plane, which was favorable for the closure of the open bite.

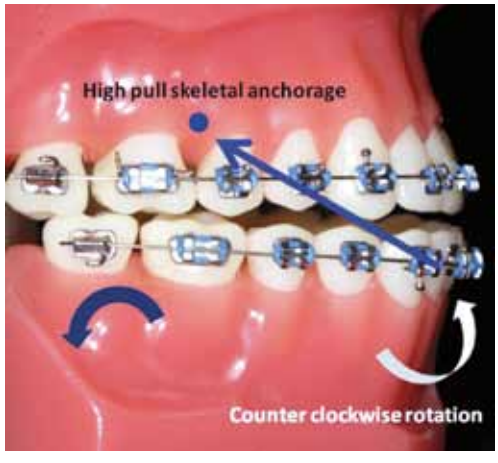

Fig. 8 Class III elastic traction in combination with TADs place in upper posterior region, the efficient vertical control during lower canines and incisors retraction can be achieved.

Fig. 9 Bone-anchored maxillary protraction (BAMP)

deciduous or early mixed dentition, before the maxillary growth cessation. Face mask is a preferred appliance, heavy anterior traction is applied on the maxilla to stimulate maxillary development and restrain or redirect the mandibular growth. However, it has many disadvantages including a lack of esthetics and discomfort. Moreover, due to the force that applies indirectly to the circum-maxillary suture through tooth-borne anchorage, causes both skeletal and dental changes because the applied force is directed below the center of resistance of the maxilla.[15] This may result in a counterclockwise rotation of the maxilla, clockwise rotation of the mandible, labial tipping of the maxillary incisors, and lingual tipping of the mandibular incisors. Many reports found the increase of vertical dimension due to counterclockwise rotation of the maxilla and clockwise rotation of the mandible after Face mask treatment.[16-19] Furthermore, the usual effects of Face mask on the dentition including extrusion and mesial movement of the maxillary molars, proclination of the maxillary incisors, and retroclination of the mandibular incisors are observed as consequences of the forces on the teeth.[16, 19] In addition, its wearing time is limited to only 14 hours per day. Due to these limitations and the undesirable side effects of the Face mask, Class III elastic traction in combination with many techniques that is aimed to correct skeletal Class III malocclusion without the Face mask side effects have been proposed.

In the 1980s, Ferro, et al (2003) proposed a new orthopedic approach-splint, Class III elastic traction and chincup for Class III (SEC III). It composes of two removable splints with hooks for Class III elastic traction and a chincup. Elastics deliver a force of 150 to 700 gram on each side and are attached to buccal hooks on either side of the intraoral appliance, distal to the maxillary last molars and between the mandibular canines and lateral incisors. The vector of the chincup force is through the maxillary first molars; total amount of force is approximately 300 to 1500 gram per side. Patients are instructed to use splints and elastics for 16 to 18 hours per day. The two splints with flat occlusal plane would facilitate correcting the Class III relationship, eliminate both intercuspation and aggravating factors, such as anterior tongue thrust. The successful results and high percentage of long-term stability at the end of the facial growth of this appliance was reported.[20]

Pertaining to undesirable dento-alveolar effects of the Face mask treatment, skeletal anchorages have been proposed in combination with Class III elastic traction in order to transfer orthopedic forces directly to the circum-maxillary sutures. De Clerck, et al (2009 and 2010) developed bone-anchored maxillary protraction (BAMP) by using Class III elastic traction between miniplates in the zygomatic crests and in the anterior mandibular region (Fig. 9). Three week after surgery, class III elastics were applied with an initial force of about 150 gram on each side, increased to 200 gram after 1 month of traction, and to 250 gram after 3 months. With this technique, extra-oral Face mask was no longer needed and Class III inter-maxillary elastic traction could be applied 24 hours a day. They reported that this technique had a successful treatment of class III patients without dento-alveolar side effects and no deformation in vertical dimension. In addition, more favorable patient compliance in comparison with Face mask treatment was reported.[1-21] Heymann, et al (2010), using three dimensional superimposition of patients who were treated with this technique, found that the effects were throughout the nasomaxillary structures, and that all patients showed improvements in the skeletal relationship, primarily through maxillary advancement with little effect on the dento-alveolar units.[22] Moreover, De Clerck, et al (2012) reported posterior displacement of the mandible, remodeling of the glenoid fossa at the anterior eminence, and bone resorption at the posterior wall, in patients were treated with this treatment approach. They suggested that this new treatment approach offered a promising alternative to restrain mandibular growth for Class III

patients with a component of mandibular prognathism or to compensate for maxillary deficiency in patients with hypoplasia of the midface.[23] However, one disadvantage of this technique was the necessity for surgical placement and removal of the bone plate.

To reduce the surgical procedure, Esenlik, et al (2015) proposed the use of Class III elastic traction between maxillary self-drilling mini-implants and mandibular miniplates. Class III elastic traction was applied with 75 gram of force on both sides one week after surgical procedure. After three weeks, the force was increased to 200 gram on both sides. They reported that this approach could protract the maxilla and improve the facial profile in a case of skeletal Class III malocclusion without dento-alveolar side effects.[24] Furthermore, Aglarci, et al (2016) compared the results of the Face mask therapy (400 gram of force per side, 20° to 30°downward from the occlusal plane) and the skeletal anchorage group, maxillary mini-implants and mandibular mini-plates for Class III elastic traction (75 gram of force on each side and increase to 200 gram of force on each side after 3 weeks), and reported that favorable skeletal outcomes could be achieved and undesired dento-alveolar effects of the Face mask treatment were eliminated, with the skeletal anchorage group.[25]

3. Class III elastic traction as an anchorage reinforcement in the other situations

In cases with severe lower anterior crowding or lower anterior protrusion, where a maximum anchorage support in the lower arch is needed. Class III elastic traction to upper molars, worn simultaneously with headgear might be used during the lower arch retraction in order to reinforce the anchorage.[2] In addition, Class III elastic traction in association with TADs could be used as absolute anchorage.[26] Ishida, et al (2013) reported the use of Class III elastic traction that applied from the mandibular first premolar to the zygomatic anchorages could successfully upright the mandibular molars and level the mandibular teeth in a camouflage treatment of skeletal Class II patient without the use of maxillary dentition and also extra-oral appliances as the anchorages. With this technique, the reciprocal force on the maxillary dentition can be avoided (Fig. 10).[26]

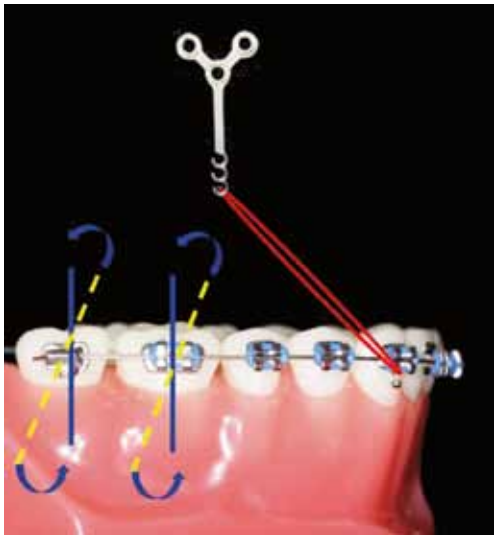

Fig. 10 Applying Class III elastic traction to zygomatic anchorages can upright the mandibular molars and leveling the mandibular teeth without reciprocal forces on the maxillary dentition.

Conclusion

Basic designs of Class III elastic traction are 1). Classical design and 2). Triangular class III elastic traction, with or without upper lateral incisors engaged. Class III elastic traction can be used in 1). Non-growing patients 2). Growth modification, and 3). Class III elastic traction as an anchorage reinforcement in the other situations. Various applications are also presented as follows, 1). Class III elastic traction with accentuated curve of Spee archwires, 2). Class III elastic traction in multiloop edgewise archwire appliance, 3). Class III elastic traction with headgear for lower arch retraction, 4). Class III elastic traction with TADs, and 5). Class III elastic traction with bone-anchored maxillary protraction. Modifications to counter side effects of using class III elastic traction are for example, transpalatal arch, Nance lingual arch, modified bracket systems, modified arch wire, multiloop edgewise archwire, extra-oral appliance, and TADs. The satisfactory treatment results had been reported.

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