Use of rhythmic wire system with miniscrews to correct occlusal-plane canting

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Occlusal-plane canting is a challenging problem for orthodontists because it cannot be solved easily without surgical intervention. Normally, a LeFort I osteotomy and concomitant mandibular surgery is used to correct the problem, even in patients with mild facial asymmetry but with noticeable occlusal-plane canting. Skeletal anchorage can be used in patients with occlusal canting to reduce the need for orthognathic surgery. The purpose of this article was to introduce a biomechanical system—rhythmic wire—to correct occlusal-plane canting. The records of 2 patients treated with this system are shown. (Am J Orthod Dentofacial Orthop 2010;137:540-7)

The cant of the occlusal plane in the frontal plane can be the result of skeletal asymmetry of the jaw bones or the asymmetric vertical position of anterior or posterior teeth. Before the advent of skeletal anchorage in orthodontics, the correction of occlusal-plane canting had only limited indications, whether the origin was skeletal or dental. Therefore, surgery was considered the only method for correcting this problem. However, skeletal anchorage has made possible true intrusion of molars, which was difficult with conventional orthodontic means. Moreover, it is now possible to correct occlusal-plane canting by controlling the vertical position of the molars.

It was reported that all people have some craniofacial asymmetry, even in esthetically normal or pleasing faces. In addition, an occlusal cant in most normal patients might be too small to detect. Padwa et al reported that 4° is the threshold for recognizing an occlusal cant. However, they measured occlusal-plane canting from a horizontal line connecting the supraorbital rim. In our experience, patients often recognize their occlusal canting as being unpleasant esthetically when there is a discrepancy in parallelism between the lip line and the occlusal plane. In some patients with vertical asymmetry of the right and left posterior teeth without anterior occlusal-plane canting, the occlusal canting becomes obvious after orthodontic leveling. Facial asymmetry that is too minimal for orthognathic surgery but accompanies recognizable occlusal canting can be corrected by skeletal anchorage-reinforced orthodontic treatment. However, few biomechanical systems use skeletal anchorage to correct occlusal canting.

We developed a biomechanical system called “rhythmic wire,” which consists of 2 miniscrews (on the maxillary and mandibular teeth), intrusion wire, extrusion wire, transpalatal arch, and lingual arch. This report presents the use of this method in 2 patients for correcting the occlusal cant to avoid or minimize orthognathic surgery.

RHYTHMIC WIRE

Rhythmic wire was initially developed to control the vertical position of the posterior teeth and consists of intrusion rhythmic wire and corresponding extrusion rhythmic wire. In addition, a transpalatal arch or a lingual arch can be applied if there is a need to control the third-order torque of posterior teeth that face an intrusion or extrusion force. Rhythmic wire can also be a good option for patients with palatally or lingually tipped posterior teeth because buccal tipping of the teeth can occur without a transpalatal or lingual arch.

The intrusion wire is formed with 0.019×0.025-in beta-titanium alloy straight wire of appropriate length (usually the length between the first premolar and the second molar) with hooks on each end for engagement to the main archwire (Fig 1). If a decrease in the intrusion force is required, the size of wire can be reduced, or helices can be included. There is no consensus on the optimal force for the intrusion of teeth, but there
appears to be some accord between researchers that posterior teeth require more force than anterior teeth. Kalra et al\textsuperscript{16} used 90 g of force per posterior tooth, Park et al\textsuperscript{6} suggested 150 to 200 g, Umemori et al\textsuperscript{7} recommended 500 g, and Melsen and Fiorelli\textsuperscript{8} used 50 g buccolingually per posterior tooth. The intrusion wire is placed on the vestibular side of the miniscrew, which is generally placed between the second premolar and the first molar, and each end is activated to engage the main archwire (Fig 1). The point where the hooks of the intrusion rhythmic wire engage depend on the clinical need; this means that the clinician can choose the site to apply the force and change the site by adjusting the intrusion wire without replacing the miniscrew. The miniscrew should have an undercut in its head design to place the intrusion wire, and an elastomeric ring can be used to secure the intrusion wire to the miniscrew.

The intrusion rhythmic wire, which is placed on the opposite dentition, is made from stainless steel wire (or cobalt-chromium wire with heat treatment) in a clover-like form (Fig 2). An indentation is prepared on the top half circle (vestibular side) to accept the miniscrew head, and each root (occlusal side) has a hook for attachment to the main archwire. Figure 2 shows its configuration and activation. Activation is achieved by manipulation of the horizontal loops. A smaller force than for intrusion is sufficient for extrusion of the teeth. However, to prevent deformation of the wire, its size should be greater than 0.016 in, and stainless steel wire is recommended. Helices or loops can be added to reduce the force (Fig 3). The intrusion and extrusion rhythmic wires should be used simultaneously to maintain the integrity of the occlusal contacts. In addition, the position of the hooks is determined by the clinical situation.

The extrusion or intrusion of molars from the buccal side can cause buccal or lingual crown tipping, which is generally undesirable. To minimize this tipping, a transpalatal or lingual arch can be applied with a rectangular lingual sheath to the active (extrusion or intrusion) side, and a round sheath can be applied to the other side, as described by Rebello.\textsuperscript{17} Also, full alignment, leveling, and space consolidation are recommended before applying a rhythmic wire, and the main archwire should be rectangular stainless steel for more predictable and easy control of the posterior quadrant.

**PATIENT 1**

A 20-year-old woman was referred from a local dental clinic complaining of masticatory problems on the left side. The intraoral features showed moderate crowding of her maxillary dentition, an anterior edge-to-edge bite, and a posterior crossbite on the left side (Fig 4). The occlusal relationship was Class II molar and Class I canine on her right side, and Class III molar and canine on her left side (Fig 4). Her maxillary right posterior teeth were positioned vertically low compared with the left side (Fig 4). After reviewing her condition, she was diagnosed with skeletal Class III facial asymmetry and a canted posterior occlusal plane.

Her skeletal problems were mild, and she did not require facial changes. She refused surgery and also declined treatment accompanying the extraction of her premolars. The treatment plan was established to distalize the maxillary right posterior and mandibular left
posterior teeth with miniscrews to resolve the crowding and correct the occlusal relationships with rhythmic wire.

After distalization of the molars, aligning and leveling were performed. The leveling procedure unmasked the posterior occlusal canting and showed an apparent difference in the gingivae between the left and right sides while smiling (Fig 5). It was decided to intrude the maxillary right posterior teeth because of the excessive gingival display on the right side. Miniscrews were placed between the maxillary right second premolar and molar, and between the mandibular right second

Fig 3. Modifications of the rhythmic wire: left, a helix was included in the intrusion wire to reduce the force; right, loops were added to the extrusion wire to reduce the force.

Fig 4. Patient 1: upper row, pretreatment study model. Note the difference in the vertical heights of the molars between the left and right sides; middle and lower rows, application of the rhythmic wire system.
premolar and molar. An intrusion rhythmic wire was placed on the maxillary right posterior teeth, and an extrusion wire was placed on the mandibular right posterior teeth. In addition, a transpalatal arch and a lingual arch with a rectangular lingual sheath were applied on the right side, and a round sheath was used on the left to control the inclination of the teeth.

The occlusal cant was corrected by the intrusion of the maxillary right posterior teeth. Finishing and detailing of the occlusion was then performed, and the intruded maxillary right posterior teeth were maintained with wire ligation to the miniscrew. After removing the appliances, a canine-to-canine lingual bonded retainer was placed in the maxilla, and a wraparound retainer was used for the mandible. Superimposition of pretreatment and posttreatment lateral cephalograms showed reductions of the difference in vertical height of the right and left molars (Fig 6).

Distalization of the molars and leveling took 15 months, correction of the occlusal cant with rhythmic wires took 9 months, and finishing took 4 months. Overall, the total active treatment period was 28 months.

PATIENT 2

A 22-year-old woman visited the orthodontic department of Kyunghee University complaining of crowding of her maxillary teeth and protrusion of her lips. The intraoral examination showed maxillary and mandibular anterior crowding, and the facial examination showed...
a canted occlusal plane with asymmetric elevation of the right and left corners of the mouth during smiling that exaggerated the occlusal canting (Figs 7 and 8). The treatment plan was to extract the first premolars to resolve the crowding and lip protrusion and to apply rhythmic wire to correct the occlusal canting.

After the conventional aligning and leveling, and closure of the extraction site with retraction of the anterior teeth, rhythmic wire was applied to the right side of her dentition. The application side was determined by the amount of gingiva showing. Her occlusal canting was corrected after 4 months of rhythmic wire application. As with patient 1, a canine-to-canine lingual bonded retainer was placed on the mandibular dentition, and a wraparound retainer was used for the maxillary dentition. The total treatment duration was 18 months, which included 12 months for aligning, leveling, and anterior retraction; 4 months for correcting the canting; and 2 months for detailing. Superimposition of pretreatment and posttreatment lateral cephalograms showed reduction of the difference in vertical height of right and left molars (Fig 9).

DISCUSSION

There are many reports of intrusion of the molars; many focus on only 1 molar. Other reports on the intrusion of more than 2 or 3 teeth required more than 1 miniscrew or used miniplates. Our method required only 1 miniscrew to intrude 1 quadrant of the dentition, thereby avoiding or reducing the economic and psychologic stress to the patient from the placement of several miniscrews.

The system introduced here was called rhythmic wire because of the smooth curvature of the intrusion wire and the subsequent change in curvature as intrusion proceeds; this is reminiscent of rhythm. The advantages
of this system are the minimal need for miniscrews and the continuous constant force it exerts. The force decreases as the intrusion proceeds, but, unlike elastics, the force does not change rapidly. Because of this advantage, patients can have longer times between appointments. In addition, it is said that a light continuous and constant force is advantageous for the intrusion of teeth. The drawbacks of this method are that considerable handwork is required, and patients can feel discomfort from the transpalatal arches. Fabricating an intrusion wire is quite simple, and an extrusion wire might appear complicated but becomes simple after a little practice. Placing 4 components (intrusion wire, extrusion wire, transpalatal arch, and lingual arch) at the same time takes considerable chair time, but, after placement, chair time is fairly short because the only necessary thing is to check the wires. Prefabrication of the wires is recommended to shorten the first chair time.

Instead of an extrusion rhythmic wire, up-and-down elastics can be adopted to maintain the integrity of the occlusal contact. However, elastics rely on the patient’s cooperation and can interrupt the intrusion if they are connected to teeth planned to be intruded. In addition, elastics can be engaged as a miniscrew to a tooth, but this method can cause a sagittal force vector unless several screws are placed.

There can be vertical asymmetry of tooth positions between the right and left quadrants without apparent
facial asymmetry. The most common cause of vertical tooth position asymmetry is when unilateral posterior teeth are lost; this causes overeruption of their opposing teeth. Even when all teeth are present, there still can be a vertical asymmetric tooth position caused by a dental developmental disorder (eg, prolonged retention or early loss of deciduous teeth or delayed eruption of permanent teeth) or functional problems. Patient 1 had overerupted maxillary right posterior teeth, and the conventional leveling procedure made the occlusal canting apparent on the anterior teeth.

The process of determining which quadrant can be intruded or extruded is associated with dental esthetics. Maxillary incisor exposure in the lip-rest position and gingival and maxillary incisor exposure while smiling should be considered. It was suggested that 3 to 5 mm of maxillary incisor exposure in the lip-rest position and three quarters of incisor length to 2 mm of gingival exposure during smiling are esthetically pleasing. This guideline can be a good aid for determining the extent of extrusion or intrusion. The patients presented here were believed to have excessive gingival exposure on the right side while smiling, and treatment was directed to intrude the maxillary right posterior teeth.

The importance of the smile arc, and the relationship of the curvature of the incisal edges of the maxillary incisors and canines with the curvature of the lower lip in the posed smile in esthetics have been noted. A rhythmic arch on both the right and left sides can be considered if there is a flat or steep occlusal plane and the smile arc is not consistent with the lower lip line. The occlusal plane can be changed without apparent changes in jaw position. However, the effect of occlusal-plane inclination to occlusion should also be considered. Braun and Lengan reported an approximately 0.5-mm change in the occlusal relationship for each degree of occlusal-plane rotation.

Several studies on the effect of molar intrusion on the dental and parodontal tissues have been reported. Kanzaki et al investigated the remodeling of the alveolar bone crest when several teeth were intruded simultaneously. Their results showed that alveolar bone crest resorption and remodeling occurs with tooth intrusion. They concluded that bone remodeling prevented deepening of the gingival pockets. In addition, Sugawara et al reported that no pseudopockets were observed after mandibular molar intrusion. Daimaruya et al carried out an animal study on the effect of molar intrusion on the nasal floor and tooth roots. They achieved 4.2 mm of intrusion after 7 months. Histology showed a thin layer of newly formed bone covering the intranasally projected root without serious pathologic changes in the pulp of the tooth. However, there was moderate root resorption. Umemori et al reported open-bite patients who had been corrected by intrusion of the mandibular molars with skeletal anchorage. They achieved 3 to 5 mm of intrusion without serious side effects. According to the above-mentioned studies, molar intrusion is a safe tooth movement and can be a good alternative to orthognathic surgery for the impaction of molars. Nevertheless, there are some limitations with this modality because of root resorption during molar impaction.

CONCLUSIONS

Rhythmic wire is a valuable method for the correction of occlusal canting. This procedure makes it possible to avoid orthognathic surgery in patients with occlusal-plane canting. However, further studies are needed to verify the stability and functional aspect of the achieved occlusal canting correction.

REFERENCES


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