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Improved Super-elastic Ti-Ni Alloy Wire for the Treatment of Skeletal Class III with Unilateral Buccally Positioned High Canine

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Abstract
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Keywords
: Buccally positioned high canine; Gingival recession; Improved super-elastic Ti-Ni alloy wire (ISW); Asymmetric extraction

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CASE REPORT

Improved Super-elastic Ti–Ni Alloy Wire for the Treatment of Skeletal Class III with Unilateral Buccally Positioned High Canine

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ABSTRACT

A 20-year-old male adult came to the clinic with a chief complaint of poor dental alignment. Clinical examination had revealed Skeletal Class III with an upper right buccally positioned high canine, anterior crowding, midline deviation and both maxillary lateral incisors crossbite. Four bimaxillary premolars were extracted. Improved super-elastic Ti–Ni alloy wire (ISW, developed by Tokyo Medical and Dental University) leveling was performed to relieve the crowding and to correct the high canine and midline deviation. Intermaxillary elastics (IME) was applied for a better interdigitation. Treatment was completed within 29 months and a desirable occlusion was achieved. *Taiwanese Journal of Orthodontics 2023;35(2):96–106

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INTRODUCTION

There are various potential causes of buccally positioned high canine, such as anomalies during the long eruption path of the canine as well as the genetic pattern. Moreover, buccally positioned high canines and the dental arch are frequently related, which may result from the lack of space, ankylosis, trauma, odontoma, root dilaceration, or early loss of primary canine.1,2

Aside from aesthetic concerns, a buccally positioned high canine can result in several other issues, including root resorption to adjacent teeth, formation of dentigerous cysts, discomfort and some gingival problems.2 Research has shown that ectopic canines can lead to increased plaque and gingival bleeding index, greater pocket depth, reduced attached gingival width, and gingival recession.2 Moreover, gingival recession is more frequently observed in buccally erupted canines.3 Orthodontic treatment has been linked to an increased susceptibility to gingival recession. The specific risk factors include a free gingival margin thickness of less than 0.5 mm and excessive anterior teeth inclination. Factors such as gingival thickness and tooth positioning can contribute to the occurrence of gingival recession, with a particular emphasis on the inclination of anterior teeth as a potential driver of undesirable gingival outcomes.5

Various techniques can be applied to correct the position of buccally ectopic canine. The most frequently utilized method is bent wires, such as T-loop and three-dimensional canine loop.6–8 In this case, improved super-elastic Ti–Ni alloy wire (ISW) was used to achieve alignment of the canine in a relatively brief period.
CASE REPORT

Clinical findings

A 20-year-old male adult came to the clinic with a chief complaint of poor dental alignment. The pre-treatment photographs showed facial asymmetry and chin deviated to the right. The intraoral examination revealed the patient had a Class I molar relationship on the right side and Class III molar relationship on the left side with an upper right buccally positioned high canine, anterior crowding, midline deviation and both upper lateral incisors crossbite (Figure 1).

The panoramic film radiograph showed existence of tooth 18, 28, 38 and 48. Initial lateral and posteroanterior cephalometric radiographs were taken in centric occlusion with closed lips (Figure 2). The cephalometric analysis demonstrated a Skeletal Class III relationship (ANB: −2.0°) and a normal mandibular plane angle of 26.5°, proclined upper incisors (U1 to FH plane angle: 118.0°) and retroclined lower incisors (L1 to mandibular plane angle: 85.5°) (Table 1).

Treatment objectives

- Achieve appropriate overbite and overjet.
- Correct the 13 buccally positioned high canine and 12, 22 crossbite.
- Coordinate dental midline.
- Establish good dental occlusion and arch coordination.

Figure 1. Pretreatment facial and intraoral photographs.
Treatment alternatives

Two feasible treatment alternatives were proposed to the patient.

- The first option involved crowding relief and dental compensation for the skeletal Class III malocclusion. The extraction of bimaxillary bilateral premolars (15 and 24) relieves dental crowding and facilitates the alignment of the high canine within the occlusion and midline correction. Extraction of 34 and 44 is for camouflage correction for the Class III by lower anterior retraction. This was followed by full mouth bonding and ISW leveling. Subsequently, space closure would be performed following with finishing and detailing procedures.

- The second approach encompassed 2-jaw orthognathic surgery, aiming to correct occlusal plane canting and facial asymmetry. The treatment approach would be the extraction of bimaxillary bilateral first premolars (14 and 24) to create space for maxillary crowding relief, non-extraction in lower arch with dental decompensation. Subsequently, Le Fort I osteotomy was performed on the maxilla to decanting and correct midline deviation. Additionally, bilateral sagittal split ramus osteotomy (BSSRO) was employed on the mandible to harmonize facial asymmetry. These surgical interventions contributed to the comprehensive treatment plan, aiming for functional and facial aesthetic improvements.

After thoroughly discussion, the patient declined the surgical treatment and favored the non-surgical approach.

Treatment progress

Before orthodontic treatment, teeth 15, 24, 34 and 44 were extracted. Initial leveling progressed over bimaxillary arch with 0.016-inch x 0.022-inch ISW. Tooth 14 distal drive was performed with elastic...
Canine distal drive (23, 33, 43) with 100gf of improved super-elastic nickel-titanium alloy closed coil springs was performed at the same time. Stoppers were installed at the mesial sides of 16 and 26 for maximum anchorage design (Figure 3).

Two months later, 100gf of improved super-elastic nickel-titanium alloy open coil spring was placed between 11 and 13 for space creation. At the same time, elastic chain was applied on 21 and 22 for upper midline correction. The 12 crossbite was correcting by ISW leveling and labial traction (Figure 4).

Five months after leveling, both upper and lower crowding were relieved. The brackets bonded on 12 and 22 were changed to the bracket designed for lower anterior tooth for better root torque control. While engaging the archwire into the bracket slot, which can successfully provide buccal root torque of the 12 and 22 (Figure 5).

In the 19th month of the treatment, ISW curve was applied at the lower arch for anchorage reinforcement on the lower posterior teeth. ISW curve is an arch commonly utilized to correct the curve of Spee. The effect of ISW is to control extrusion of the

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<td>U-1 to FH plane</td>
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<td>U-1 to SN plane</td>
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In the 19th month of the treatment, ISW curve was applied at the lower arch for anchorage reinforcement on the lower posterior teeth. ISW curve is an arch commonly utilized to correct the curve of Spee. The effect of ISW is to control extrusion of the
posterior teeth as well as intrusion and flaring of the lower anterior teeth. The force of wires flares the anterior teeth also mesially drive on posterior anchorage. The way that avoids the possible anchorage loss is to ligate the lower anterior teeth together (serial ligature tied, SLT) and move forward of posterior teeth one by one (Figure 6).

In the 23rd months, Class II intermaxillary elastic (IME, 3M Unitek Elastics, 3.5 oz, USA) was applied between 14-46 and 25–36 for buccal interdigititation. IME traction was used over the bilateral lower first molars. The lower molar extrusion contributed to clockwise rotation of the mandible. IMEs were employed as part of the orthodontic treatment to establish a connection between the upper and lower teeth. In addition, such mandibular clockwise rotation enhances the anterior overbite reduction, improve vertical control and facial asymmetry correction. At the same time, ISW curve was added on the lower arch for the correction of lower anterior lingual tipping (Figure 7).

After 29 months of orthodontic treatment, active treatment was finished, and full mouth brackets were debonded. Circumferential retainer was delivered for the upper arch and Hawley retainer for the lower arch.

Treatment result

The results showed that the patient’s dental problems were improved through orthodontic treatment. Anterior crowding was relieved, the dental midline was coincident, and the buccally high canine was aligned into the occlusion (Figure 8).

The post-treatment cephalometric radiographs showed the proclined upper incisors was corrected (U1 to FH plane: 118.0°→113.5°). The mandibular plane angle was decreased from a pretreatment angle...
of 26.5° to a post-treatment angle of 26.0°, so the mandible was rotated in counterclockwise direction (Table 2). The panoramic radiographs show well-aligned root parallelism of the teeth (Figures 9 and 10).

DISCUSSION

Throughout the entire treatment, ISW was employed in combining with fixed appliances consisted of preadjusted brackets following a Roth 0.018-inch prescription (TOMY, formula-R, Japan). This case was benefited from the advantages from ISW, which includes the shape memory, the super-elasticity, and the reduced shock and vibration absorption. Besides its super-elastic properties, the ISW offers the advantage of engaging the buccally positioned high canine into the bracket slot early in the treatment, enabling effective control over root torque. The utilization of ISW in conjunction with proper bracket positioning facilitates efficient root torque control, contributing to the overall success of the orthodontic treatment. The characteristics of ISW allow the procedure to exert consistent orthodontic forces that remain unaffected by changes in intra-oral temperature.

The ISW exhibited an earlier onset of martensitic transformation, a lower critical stress required to reach the loading plateau, and reduced stress hysteresis compared to the Sentalloy wire. Furthermore, the ISW exhibited lower frictional resistance than the Sentalloy wire across all bending deflections for a constant. While friction is influenced by multiple factors, ISW low-stress hysteresis and enhanced sliding properties, has the potential to facilitate bracket movement along the archwire. In providing patients with a gentle bending sensation,
ISW’s minimal load-hysteresis generates exceptionally light orthodontic forces. In addition, the application of an extremely smooth coating on the archwire surface, which reduces archwire friction significantly. As a result, ISW contributes to improve both treatment precision and patient comfort.

Regarding the brackets, by adjusting the tightness of the ligatures could control their effects easily. For instance, a loose tie allowed for wire sliding, while a tight tie facilitated tooth movement along with the wire. This versatility in bracket management simplified the achievement of the treatment objectives.

Unilateral buccally positioned canine usually led to midline deviation. Therefore, an asymmetric extraction strategy may be helpful during the orthodontic treatment. Due to the midline shift to the right in this case, the extraction of teeth 15 and 24 were decided to facilitate midline correction with consideration of anchorage of different on both sides. At the end of the treatment, the upper midline had been corrected to the left by 4.0 mm.

According to Artun et al. (1986), gingival recession was observed more frequently among buccally erupted canines. Thomas et al. (1980) found that there are 33% of high buccally erupted canines encountering gingival recession. Although high canines with higher possibility to have thin buccal bone plate with association of gingival recession. The eruption of a buccally positioned high canine is
often accompanied by buccal root positioning, which can lead to progressive bone resorption and gingival recession over time. This undesirable consequence poses a challenge in orthodontic treatment as it negatively impacts the esthetics and periodontal health of the affected tooth. As a result, there are more evidence prove that orthodontic treatment can prevent gingival recession.11 In this case, it was observed buccally positioned high canine 13. Considering the dynamic nature of orthodontic treatment, decision was made to evaluate the need for gingival grafting following treatment once the occlusion has stabilized. The unique properties of the ISW wire allow for effective control of root torque during orthodontic treatment. By engaging the wire into the bracket slot, can promote palatal root torque thereby facilitating the correction of buccally positioned teeth. This controlled root torque manipulation is crucial in achieving optimal alignment and positioning of the teeth, ultimately leading to improvements in gingival recession. By carefully guiding the canine into the alignment, subsequent gingival recession of tooth 13 was avoided and improved significantly after subsequent gum care and massage (Figure 11). Considering the patient's acceptance of the existing level of gingival recession, the patient declined the option of undergoing gingival grafting following the completion of orthodontic treatment. The patient's decision was based on a personal preference, acknowledging, and embracing the current condition of their gingival tissues.

Orthodontic management of buccally positioned high canine may be quite challenging and can encounter some difficulties, such as local crowding for fully engaging the wire achieve bodily movement.12 It usually requires wire bending or even mini-screw to achieve desired alignment. However, in this case, due to the super-elasticity of the ISW, the wire can easily engage into a buccally positioned high canine on the first day for active treatment and facilitate canine alignment. And the canine was extruded 5.0 mm with a constant force from ISW within 5 months (Figure 12).

There are several ways to close the space between the posterior teeth, but in this case, ISW heated curve was used as reinforced anchorage with elastic chain. During mesial drive was performed, the elastic chain was applied only on tooth 46. Tooth 47, 48 spontaneously followed forward due to the traction forces from transseptal fibers of PDL (Figure 13).
Figure 9. Post-treatment lateral, posteroanterior cephalograms and panoramic radiograph.

Figure 10. Superimposition of before and after treatment.
Figure 11. Improvement of gingival recession.

Figure 12. The super-elasticity of the ISW.

Figure 13. Space closure of posterior teeth.
CONCLUSION

This case features a patient with unilateral buccally positioned high canine, midline deviation, anterior crowding, and upper lateral incisors cross-bite. By ISW leveling along with changing the specific brackets can achieve crowding relief, midline coincident, anterior crossbite and high canine correction to benefit the gingival recession. Additionally, curve technique with Class II IME was performed to achieve adequate overbite. After 29 months of active treatment, a normal occlusion and desirable cusp interdigititation were achieved.

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ETHICAL APPROVAL

Not required.

PATIENT CONSENT

Provided.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

REFERENCES


