iAOI Case Report

Highly Positioned and Transalveolar Impacted Maxillary Canine

HISTORY AND ETIOLOGY

A 13-year-7-month-old female was referred for orthodontic consultation (*Figure 1*). Her chief concern was the edentulous space for an unerupted permanent canine (*Figure 2 and 3*). A specific surgical plan to expose and retract the impacted canine was proposed. There was no contributory medical or dental history. Clinical examination revealed bilateral Class I molar relationship and minor crowding in both arches. The patient was treated to an acceptable result as documented in Figures 4-9, as will be subsequently discussed.

DIAGNOSIS

A pretreatment cone beam computed tomography (*CBCT*) scan indicated that the canine was horizontally impacted in a high labial position, about 14 mm away from the crest of the alveolar ridge (*Figure 10*). The crown of the horizontal impaction was apical to the adjacent teeth, and its cusp tip was oriented toward the labial.

Skeletal:

Skeletal Class I (SNA 81°, SNB 78°, ANB 3°) Mandibular plane angle (SN-MP 36°, FMA 31°) Dental:

Bilateral Class I malocclusion

The overbite and overjet were both 4 mm.

Slight crowding in both the upper and lower arches

Facial:

Straight profile with acceptable lip position The IBOI Discrepancy Index (*DI*) was 12 as shown in the subsequent worksheet.



Fig 1. Pretreatment facial photographs



Fig 2. Pretreatment intraoral photographs



Fig 3. Pretreatment study models

Dr. Billy Su, Director, Newtons Implant Center (right) Dr. Chris HN Chang, Director, Beethoven Orthodontic Center (middle) Dr. Eugene W. Roberts, Consultant, International Journal of Orthodontics & Implantology (left)





Fig 4. Posttreatment facial photographs



Fig 5. Posttreatment intraoral photographs



Fig 6. Posttreatment study models

SPECIFIC OBJECTIVES OF TREATMENT

Maxilla (all three planes):

- A P: Maintain
- Vertical: Allow for normal expression of growth
- Transverse: Maintain

Mandible (all three planes):

- A P: Allow for normal expression of growth
- Vertical: Allow for normal expression of growth
- Transverse: Maintain

Maxillary Dentition

- A P: Maintain
- Vertical: Maintain
- Inter-molar Width: Maintain

Mandibular Dentition

- A P: Maintain
- Vertical: Maintain
- Inter-molar / Inter-canine Width: Maintain

Facial Esthetics: Maintain

TREATMENT PLAN

Non-extraction treatment with a full fixed orthodontic appliance was indicated to align and level the dentition. In the initial stage of treatment, space was opened for the impacted canine and the patient was referred for surgical exposure (*Figure 11*). The closed eruption technique (*CET*) was selected due to the relatively high, horizontal position of the impacted tooth (*above MGJ*). After crown exposure, two buttons were bonded with power-chains (*PC*) attached, on the lingual and labial surface of the impacted canine (*Figure 12*). To prevent the



Fig. 7. Pretreatment pano and ceph radiographs

Fig. 8. Posttreatment pano and ceph radiographs



Fig 9. Superimposed tracings



Fig. 10. A 13y 7m female with an impaction 14 mm away from the alveolar ridge.



Fig. 11.

A flap was used to expose the impaction and remove the bone until CEJ.



Fig. 12.

Bond buttons on the labial and buccal side of the impaction and use color-coded power chains as markers.

archwire from deforming and causing iatrogenic tooth movement, the traction anchorage was via an extra-alveolar miniscrew (2x12 mm, OrthoBoneScrew, Newton's A, Inc.) inserted in the infrazygomatic crest (Figure 13). Figure 14 shows primary closure of the wound. The PCs were activated with a lever arm of 17x25 SS (Figure 15) anchored by the miniscrew. The traction force was independent of the rest of the dentition; it was easily activated by adjusting the length of the PC chain and the lever arm in three dimensions (Figure 16). The gingival dynamics and third order control of the recovered canine, illustrated in Figures 17-21, will described in the discussion section.

Anterior bite turbos were used for correction of the 4 mm overbite (*Figure 22*). Class II elastics were used to resolve the sagittal occlusal discrepancy, and detailing bends produced the final occlusion. Fixed appliances were removed and the corrected dentition was retained with fixed anterior retainers on the lower arch and a clear overlay on the upper arch.



Fig. 13.

Place a miniscrew on the IZC. Create a lever arm and insert it into the screw. Connect the impaction and the screw with power chains on both ends to generate a downward traction force.



Fig. 14.
Suture the flap with primary closure.



E Fig. 15.

11 months in treatment. Provide a continuous downward force by bending the lever arm.

APPLIANCES AND TREATMENT PROGRESS

0.022" slot Damon D3MX brackets (*Ormco*) were selected. After 4 months of creating space with an open coil spring, surgical exposure and orthodontic traction were ready to start. The closed eruption technique was selected due to the relatively high position of the impacted tooth (>8mm above the MGJ) (Figure 10).

The brackets were debonded from the maxillary left lateral incisor and first premolar, and an open coil spring was placed between adjacent central incisor and 2nd premolar to maintain a pathway for the extrusion of the impacted canine (*Figure 15*). Three dimensional adjustment of the lever arm provided a continuous traction on the impaction for 3 more months to move the canine crown at the level of the occlusal plane.

At the 15th month of the treatment, a panoramic radiograph and intra-oral occlusal photographs were obtained to evaluate root angulation and crown rotation. We removed the buttons, bonded brackets and changed back to the light wire (*.014 NiTi*) for leveling the impaction. The wire sequence was as follows: .014NiTi, .014x.025 NiTi, .017x.025 TMA, and .019x.025 SS. Anterior bite turbos with Class II elastics were used to correct the A-P discrepancy and

overbite. The root torque of the impacted canine was corrected with a torquing spring.

One month prior to the completion of active treatment, the upper archwire was sectioned distal to the cuspids. Light vertical elastics (2 oz) were used for final detailing of the buccal segments. After 26 months of active treatment, all appliances were removed; upper clear overlay and lower fixed anterior retainers were delivered for both arches.

CEPHALOMETRIC SKELETAL ANALYSIS PRE-TX POST-TX DIFF. **SNA°** 82° 1° 81° **SNB°** 78° 78° 0° **ANB°** 3° 4° 1° 1° SN-MP° 36° 37° FMA° 1° 31° 32° **DENTAL ANALYSIS** U1 TO NA mm 5mm 5mm 0mm 2° U1 TO SN° 110° 112° L1 TO NB mm 5mm 6mm 1mm L1 TO MP° 95° 100° 5° **FACIAL ANALYSIS** E-LINE UL 1mm 0mm -1mm E-LINE LL 2mm 2mm 0mm

Table 1. Cephalometric summary

RESULTS ACHIEVED

Maxilla (all three planes):

- A P: Maintained
- Vertical: Maintained
- Transverse: Maintained

Mandible (all three planes):

- A P: Favorable growth
- Vertical: Favorable growth
- Transverse: Maintained

Maxillary Dentition

- A P: Slightly flared incisors 2 degrees
- Vertical: Extruded, impacted canine recovered and optimally aligned
- Inter-molar / Inter-canine Width: Maintained

Mandibular Dentition

- A P: Flared incisors 5 degrees
- Vertical: Intruded incisors; extruded molars
- Inter-molar / Inter-canine Width: Maintained

Facial Esthetics: Improved

RETENTION

The lower fixed retainer 3-3 was bonded on every tooth. An upper clear overlay was delivered. The patient was instructed to wear it full time for the first 6 months and nights only thereafter. The patient was instructed in the home care and maintenance of the retainers.

FINAL EVALUATION OF TREATMENT

The IBOI Cast-Radiograph Evaluation scored at 26 points, which was deemed to qualify as a board case report. The major discrepancies were problems in alignment/rotation, marginal ridge discrepancies, and occlusal relationships. The impacted canine was well aligned, and all of the canine and molar relationships were near ideal. The scar formation on

the gingival texture on [#]23 was shown (*Figure 25*), and there was more root prominence labial root prominence than for the opposite canine (*Figure 24*). Over-correction of the impacted canine was noted.

Collectively, flaring of the maxillary and mandibular incisors resulted in regaining of space and the overjet was corrected. The use of Class II elastics to anteriorly position the mandibular dentition was necessary, because there was insufficient anterior growth of the mandible. Overall, this difficult impaction case was treated to an appropriate facial and dental result with no iatrogenic problems.

DISCUSSION

Three dimensional CBCT imaging was essential for designing a treatment plan for the impacted canine to reveal the relationships among the impacted tooth, adjacent teeth and the cortical bone. Three types of 3D images are required: 1. 360° rotated animation around the impaction covered with bone. 2. 360° rotated animation around the impaction with the bone covering deleted. 3. Crosssectioned slice through the impaction. These three images are necessary for selecting an appropriate surgical technique, as well as for designing a precise force system to align the impacted tooth without damaging the roots of adjacent teeth. An additional consideration is the management of the path of tooth movement to avoid inhibition of the recovery by dense cortical bone.¹ Moreover, any obstacles in the designed pathway of eruption should be removed during the surgical procedure.

When dealing with a labial impaction, that is within the alveolar process, retraction with a 3D lever arm and IZC miniscrew is indicated, Since the impaction is well above the mucogingival junction, closed eruption technique and an apically positioned flap (*APF*) are both important considerations. According to Dr. Kokich's article in 2004, closed eruption technique is more appropriate than an APF when the impaction is in a high position, such as for the present case, which is 14mm apical to the alveolar crest.

Four types of surgical techniques are applicable for recovering impactions. The open window technique is usually the most ideal for palatal impactions with the potential to spontaneously erupt into oral cavity. Since the palate is covered by keratinized gingiva, there is little consideration for the impact on soft tissue. Closed eruption technique and APF are commonly adopted procedures for buccal and labial impactions. The choice of technique depends on the position of the impaction and the conditions of the soft tissue. However, one of the main problems with the closed eruption technique is the difficulty in tension release. APF shares a similar challenge in wound closure. The apical repositioning makes it difficult to have precise control of the flap margin.

To prevent the archwire deformation and unwanted tooth movement, the traction force was produced by a lever arm made of 17x25 SS anchored with a miniscrew (2x12 mm, Stainless Steel, OrthoBoneScrew, Newton's A, Inc.) that is inserted in the infrazygomatic crest (Figure 16). At subsequent visits, the device was reactivated by cutting loops off the power chain

or adjusting the lever arm. The adjacent lateral incisor and first premolar were not bonded nor engaged on the arch wire until the canine had been moved between them.^{2,3,4} This method allows the vulnerable, adjacent teeth to act as free bodies. They are free to move out of the way of tooth movement if they are contacted by the erupting canine, and thereby iatrogenic root resorption.

During the orthodontic treatment, three stages of soft tissue change can be observed in the process of rapid traction of an impaction: Stage 1. Gingival collar redness ; Stage 2. The red patch ; Stage 3. Keratinization.⁵

Stage 1. Gingival collar redness : During the initial period of rapid forced eruption, a collar of redness is often observed around the gingival margin. This is the color of the non-keratinized epithelium tissue inside of the periodontal pocket (*Figure 17*). At this stage the pocket depth tends to be high and can be misinterpreted as poor healing or gingival inflammation. Patients should be instructed to maintain proper oral hygiene and this is in fact a normal condition.

Stage 2. The red patch : As the impaction continues to erupt occlusally, a margin of immature-appearing tissue, "the red patch", appears coronal to the



Fig 16. 2x12 mm OBS with 3D lever arm



Fig. 17.

15 months in treatment. Stage 1. Gingival collar redness. Deep probing depth was noted and careful monitor of oral hygiene was necessary.



Fig. 18.

16 months in treatment. Distalrotated canine was noted. Light round wire .014 NiTi was engaged into bracket. original gingival margin. At this stage the probing depth reduces from around 5mm to 3mm, which is in the normal range. However, the color of the gingival margin still tends to be more reddish than surrounding tissue and is easily distinguished from the keratinized gingiva (*Figure 19*).

Stage 3. Keratinization : When the impacted tooth moves into an ideal position, the surrounding gingival tissue completes is progression of proliferation and maturation. The keratinization of gingiva takes about 28-42 days (*Figure 20*).

The orifice of the gingival sulcus is bound by the tooth surface on one side and sulcular epithelium on the other, the bottom of the sulcus is frequently bordered by epithelium on all sides. The soft tissue wall of the gingival sulcus is lined coronally with nonkeratinizing epithelium, which is deemed the sulcular epithelium. For teeth that are erupted in the presence of soft tissue pocket appear to move coronally for a considerable distance before the gingival margin follows. Concurrently, the pocket depth is reduced and an immature appearing tissue, "red patch", that is sulcular epithelium, has peeled off the tooth surface directly. The nonkeratinized tissue remains erythematous for about 28 to 42 days, until keratinization occurs and it assumes the appearance of normal gingiva.⁶ It is imperative that all periodontal pathology be under control before any orthodontic treatment is attempted. A chemical agent, such as chlorhexidine, can be used during the active phase of orthodontic treatment to reduce bacterial plaque accumulation, thereby improving the gingival condition and possibly reducing the acute inflammatory process. As a result, patients with a history of periodontal compromise are placed on 0.12% chlorhexidine gluconate (*CH*) mouthrinse during the course of active eruption of an impaction.

In the 22th month of treatment, insufficient lingual root torque was noted on the recovered impaction. When the impaction forcefully erupted, the root was more labially positioned because of the relatively dense bone on the palatal surface. Hence, it is important to monitor the torque of the impacted tooth in the finishing stage. Torquing springs are useful auxiliaries (Figure 21). Root angulation and torque control, for the transalveolar impacted canine, present significant challenges. There are several methods for solving these problems: 1. Bond the canine with a high torque bracket (or inverted low torque bracket). 2. Torque the segmental wire within the canine bracket; 3. add a torquing spring³. The most efficient and effective method to generate favorable torque expression is the use of an



Fig. 19.

19 months in treatment. Stage 2. The red patch. As the impaction erupted downward to the occlusal level, the "red patch", appeared coronal to the original gingival margin and probing depth was back to normal 3 mm.



Fig. 20.

20 months in treatment. Stage 3. Keratinization. The surround gingival tissue started the progression of proliferation and maturation and the whole process took 28~42 days.



Fig. 21.

22 months in treatment. Use a single torquing spring (18X25) to increase lingual root torque.

individual root torquing spring. It can be used earlier with light rectangular archwires such as .014x.025 copper NiTi, or the wire segment in the canine slot of the heavy rectangular wire can be rounded with a handpiece in the late stage of treatment.

Class II elastics combined with anterior Bite Turbos were applied for molar extrusion and to bring the mandible forward. These mechanics significantly improved the 4mm overjet and overbite (*Figure 22*).

The initial DI score was only 10, indicating a minor to moderate malocclusion for an ABO case report⁷. However, it is necessary to also assess the complexity of a canine impaction, especially when it is 14 mm away from alveolar crest. In this regard, six points were added under the item of the additional treatment complexities to reflect the difficulty for management of a high transalveolar impaction. The final DI score was 16. The IBOI CRE score was 26 points, with most of the points reflecting problems in alignment and marginal ridge discrepancies (*Figures 26 and 27*). Pre-finish casts, obtained about six months before the end of active treatment, would have been helpful in identifying and resolving these finishing problems.

To more thoroughly evaluate the recovery and alignment of an impacted canine, the record of gingival esthetic change after impaction-related surgery is indicated.⁸ The quality of a prosthesis can also be evaluated by the measurement of the white esthetic score. Because of the scar formation, inadequate lingual root torque over impacted canine and disharmony of the curvature of gingival margin over adjacent lateral incisor, 4 points were assessed on the pink esthetic score. The Pink & White esthetic score worksheet⁹ provide a broader array of clinical parameters for patients with impacted teeth. The Pink and White Esthetic Score worksheet is demonstrated at the end of this article.



Fig. 22.

23 months in treatment. Class II elastics combined with anterior BT were applied for molar extrusion and to bring the mandible forward, which significantly improved the 4mm overjet and overbite.



Fig. 23.

Post-treatment intra-oral frontal photo. Uneven gingival margin level was noted on the upper anterior area. Gingivectomy procedure with diode laser was recommended to patient.



Fig. 24.

Occlusal view of anterior teeth showed different root torque of bilateral canine. Absence of cingulum indicated insufficient lingual root torque.



Fig. 25.

Buccal view of active treatment for 26 months. Scar formation over mucosa area of impacted canine was noted.



Fig. 26. Distal-in 1st molar was noted.



High, transalveolar impactions are difficult canines to recover. Selection of an appropriate surgical technique depends on the height (position) of the impaction and the conditions of the adjacent soft tissue. 3D imaging is particularly helpful for labial impactions or for those deeply embedded in the alveolar process. In this case, we chose the closed eruption technique and used a 3D lever arm to move the impaction occlusally. The adjacent teeth should not be bonded until the canine erupts to prevent iatrogenic root resorption. Moving a transalveolar impaction into the maxillary arch usually results in inadequate lingual root torque on the recovered canine. This third order problem should be addressed with a torqueing auxiliary druing orthodontic finishing.

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Fig. 27. Marginal ridge discrepancy over 1st and 2nd molars was noted.

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OI Discrepan	cy	Index Worksheet	
TOTAL D.I. SCORE		16	
OVERJET			
0 mm. (edge-to-edge) 1 – 3 mm.	=	0 pts.	
3.1 – 5 mm.	=	2 pts.	
5.1 – 7 mm. 7.1 – 9 mm.	=	3 pts. 4 pts.	
> 9 mm.	=	5 pts.	
Negative OJ (x-bite) 1	pt. pe	r mm. per tooth =	
Total	=	2	
OVERBITE			
0 – 3 mm.	=	0 pts.	
3.1 – 5 mm. 5.1 – 7 mm.	=	2 pts. 3 pts.	
Impinging (100%)	=	5 pts.	
Total	=	2	
0 mm. (edge-to-edge), then 1 pt. per additions	l pt. j	per tooth mm. per tooth	
Total	=	0	
LATERAL OPEN BI	TE		
2 pts per mm per toot	—— h		
	-		
Total	=	0	
CROWDING (only or	ie arc	h)	
1 – 3 mm.	=	l pt.	
3.1 – 5 mm. 5.1 – 7 mm.	=	2 pts. 4 pts.	
> 7 mm.	=	7 pts.	
Total	=	4	
OCCLUSION			
Class I to end on	=	0 pts.	
End on Class II or III	=	2 pts. per sidepts.	
Beyond Class II or III	=	4 pts. per mm. <u>pts.</u> l pt. per mm. <u>pts.</u>	
		additional	
Total	=		

LINGUAL POSTER	IOK A-	BILE		
l pt. per tooth	Total	=		0
BUCCAL POSTERI	OR X-E	ITE		
2 pts. per tooth	Total	=		0
CEPHALOMETRIC	: <u>S</u> (Se	e Instruc	tions)	
$ANB \ge 6^{\circ} \text{ or } \le -2^{\circ}$			=	4 pts.
Each degree $< -2^{\circ}$		_x l pt.	=_	
Each degree > 6° _		_x l pt.	=_	
SN-MP				
≥ 38°			=	2 pts.
Each degree > 38°		_x 2 pts	s. =_	
≤ 26°			=	1 pt.
Each degree $< 26^{\circ}$		_x l pt.	=_	
l to MP \geq 99°			=	1 pt.
Each degree > 99°		_x l pt.	=_	
	Tot	al	=[0
	200		L	0

OTHER (See Instructions)

Supernumerary teeth		_x 1 pt. = _	
Ankylosis of perm. teeth		x 2 pts. =	
Anomalous morphology		x 2 pts. =	
Impaction (except 3 rd molars)		x 2 pts. =	
Midline discrepancy (>3mm)		@ 2 pts. =	2
Missing teeth (except 3rt molars)		x 1 pts. =	_
Missing teeth, congenital		x 2 pts. =	
Spacing (4 or more, per arch)		x 2 pts. =	
Spacing (Mx cent. diastema ≥ 2mm)		@ 2 pts. =	-
Tooth transposition		x 2 pts. =	
Skeletal asymmetry (nonsurgical tx)		@ 3 pts. =	
Addl. treatment complexities	3	x 2 pts. =	6

Identify: 14 mm highly positioned and transalveolar impaction

Total

=

8

PLANT	SITE

Lip lifte I tow (0 pt), Medium (1 pt), High (2 pts)	=			
Gingival biotype : Low-scattoped, thick (0 pt), Medium-scattoped, o	m dium-thick (1 pi),			
High-scalloped, thin (2 piz)	=			
Shape of tooth crowns : Rectangular (0 pt), Triangular (2 pin)	=			
Bone level at adjacent teeth 1 at 5 mm to contact point (0 pt).	5.5 to 6.5 mm to			
contact point (1 pt), is 7mm to contact point (2 pts)	=			
Bone anatomy of alve olar crest : may sufficient (0 pt, Def	cient H, allow			
simultaneous sugment (1 pt), Deficient H, requise prior grafting (2 pts), Deficient V or Both				
HAV (3 pts)	=			
Soft tissue anatomy I intact (0 pt), Defective (2 pts)	=			
Infection at implant sile : None (0 pt, Chronic (1 pt), Acute(2 pt)	=			

Total

= 0



INSTRUCTIONS: Place score beside each deficient tooth and enter total score for each parameter in the white box. Mark extracted teeth with "X". Second molars should be in occlusion.

IBOI Pink & White Esthetic Score

Total Score: =

8

I. Pink Esthetic Score





2. White Esthetic Score (for Micro-esthetics)





Total =	5		
1. M & D Papilla	0	1	2
2. Keratinized Gingiva	0	1	2
3. Curvature of Gingival M	Margin 0	1	2
4. Level of Gingival Marg	in 0	1	2
5. Root Convexity (Torqu	ie) 0	1	2
6. Scar Formation	0	1	2

I. M & D Papilla	(0) 1	2
2. Keratinized Gingiva	0 (1)	2
3. Curvature of Gingival Margin	0 (1)	2
4. Level of Gingival Margin	01	2
5. Root Convexity (Torque)	0 (1)	2
6. Scar Formation	0 1	(2)

ſ

Total =		3		
1. Midline		0	1	2
2. Incisor Curve		0	1	2
3. Axial Inclination (5°,8°,	10°)	0	1	2
4. Contact Area (50%,40%,30%)		0	1	2
5. Tooth Proportion(1:0	.8)	0	1	2
6. Tooth to Tooth Proportion		0	1	2

1. Midline	01	2
2. Incisor Curve	0 (1)	2
3. Axial Inclination (5° , 8° , 10°)	0 (1)	2
4. Contact Area (50%,40%,30%)	01	2
5. Tooth Proportion (1:0.8)	0 (1)	2
6. Tooth to Tooth Proportion	01	2