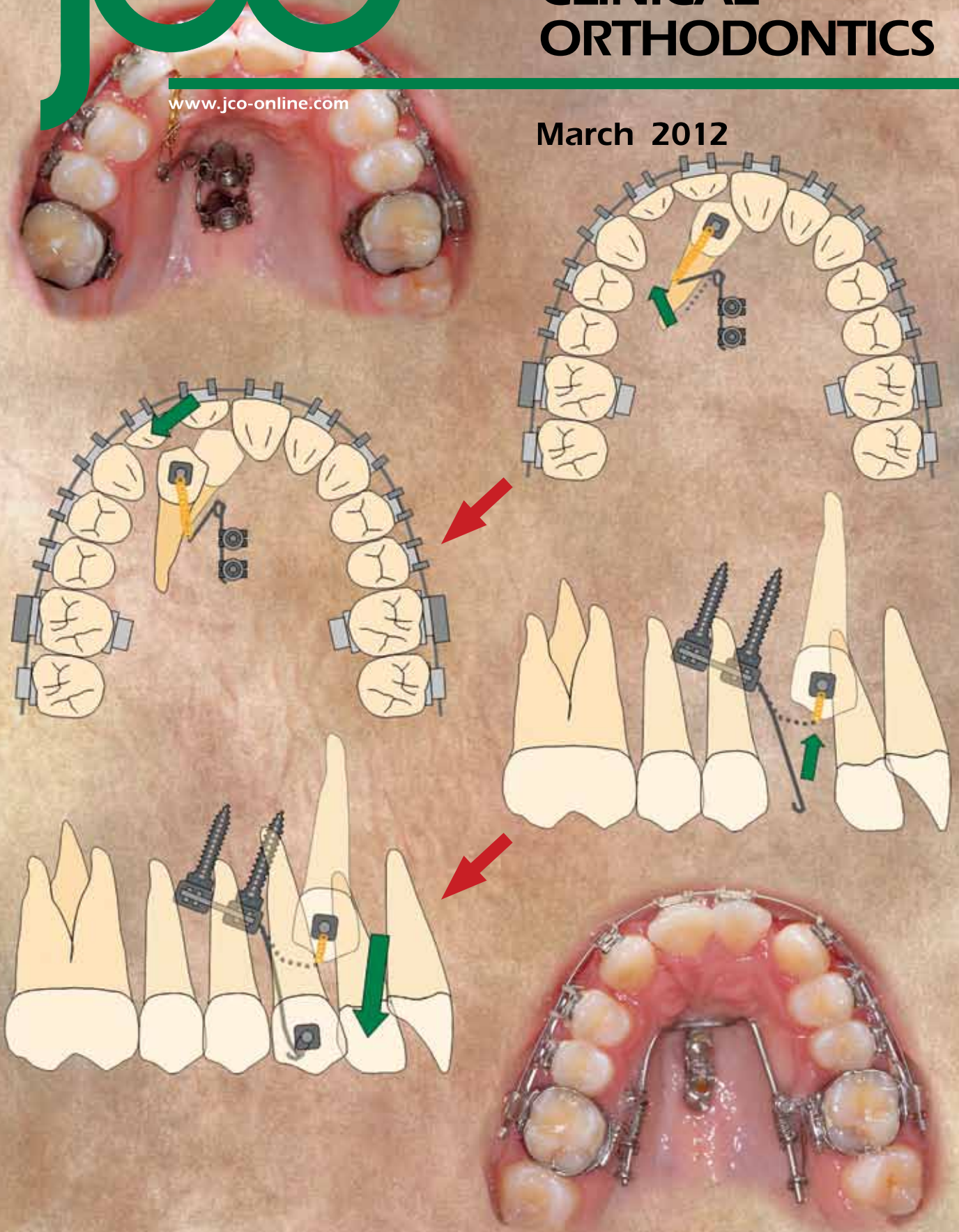


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Extrusion of Impacted Teeth Using Mini-Implant Mechanics

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Treatment of impacted teeth usually comprises three phases: surgical exposure and bonding of an attachment, eruption of the impacted tooth by application of an extrusive force, and three-dimensional orthodontic alignment.¹⁻³ The force needed to extrude an impacted tooth often produces side effects such as intrusion of the adjacent teeth or even canting of the occlusal plane.⁴ Stable anchorage is essential to minimize these effects.

In recent years, skeletal anchorage with mini-implants has become increasingly popular because of its versatility, minimal invasiveness, and low cost.⁵⁻⁹ This article presents several clinical cases in which Benefit* mini-implants with interchangeable abutments¹⁰ (Fig. 1) were placed in the anterior palate to serve as anchorage for extrusion and alignment of impacted teeth.

Depending on the anchorage needs of the case and the location of the teeth to be moved, various types of implant mechanics can be used.

Single Implant: Direct Anchorage

These simple mechanics are usually employed to extrude a single impacted tooth. Since implants with wider diameters have greater stability,^{11,12} a single mini-implant with dimensions of 2.3mm × 9mm or 2.3mm × 11mm is inserted in the anterior palate. A bracket abutment with a preligated .016" × .022" TMA** sectional wire is screwed to the head of the mini-implant (Fig. 2). The impacted tooth is surgically exposed, and an

attachment fitted with a gold chain is bonded to the tooth. To generate an extrusive force, the sectional wire is bent toward the chain and attached with a ligature.

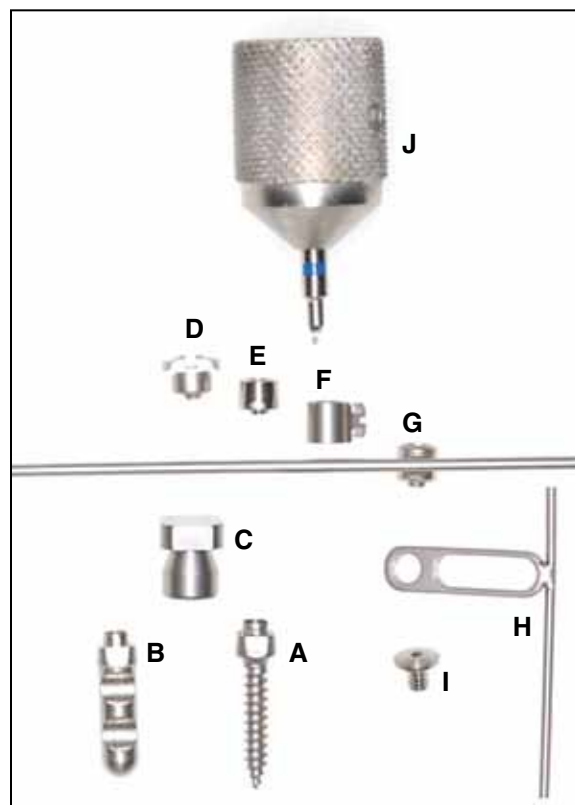


Fig. 1 Benefit* and Beneplate* system: A. Mini-implant. B. Laboratory analog. C. Impression cap. D. Slot abutment. E. Standard abutment. F. Bracket abutment. G. Wire abutment with wire in place. H. Beneplate with .031" or .043" stainless steel wire in place. I. Fixing screw for Beneplate. J. Screwdriver for abutment fixation.

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Tandem Implants: Direct Anchorage

In cases with greater anchorage needs, two 2mm-diameter mini-implants can be combined. A stable connection between the mini-implants is crucial. Although a composite bridge can be constructed, the composite may fail when subjected

to force. A better solution is to ligate the mini-implants together with a wire segment or to connect the abutments with laser-welded stainless steel wires. More individualized treatment is possible with the use of a rigid plate such as a Beneplate*¹³ (Fig. 1H). A superelastic wire can be ligated to a bracket integrated with the plate, or a prefabri-

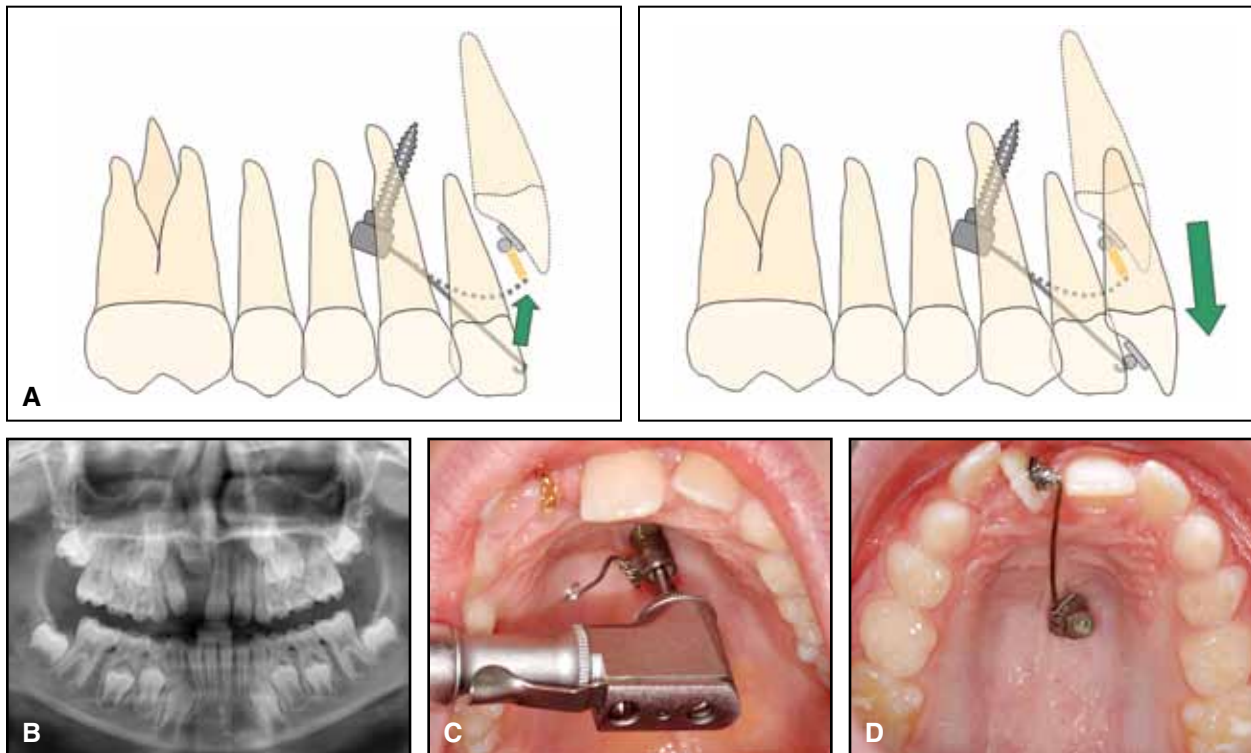


Fig. 2 Single implant: direct anchorage. A. .016" × .022" TMA** sectional wire with activation bend ligated to bracket head of implant abutment and attached to gold chain bonded to impacted tooth. B. 9-year-old male patient with impacted upper central incisor before treatment. C. After exposure of impacted central incisor, abutment with TMA sectional wire screwed to head of mini-implant. D. Patient after eight months of incisor extrusion.

cated plate with an .031" integrated wire can be used (Fig. 3).

Single Implant: Indirect Molar Anchorage

To prevent mesial tipping and intrusion of the molars during extrusion of anterior teeth, a prefabricated abutment with an .031" stainless steel wire can be used to create a skeletally anchored transpalatal arch (Fig. 4). If a tooth is buccally displaced, the forces must be applied from the buccal, using an .016" × .022" TMA extrusion arch inserted into the first-molar auxiliary tubes (Fig. 5A). Perhaps the most stable transpalatal-anchorage construction is a "triangular transpalatal arch" of .043" stainless steel wire, connecting the molar bands and the mini-implant (Fig. 5B,C). The additional transverse connector prevents buccal or

palatal tipping of the molars, resulting in complete immobilization of these teeth.

Adjustment of Force Vectors

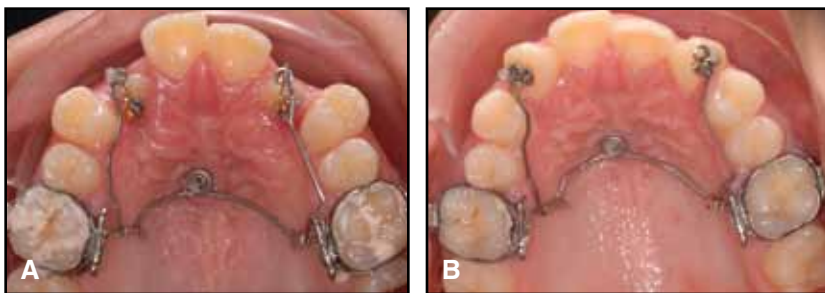
By varying the length of wire or preactivating it in a mesial or distal direction, the line of force can be adapted to the individual clinical situation. Since these mechanics can be classified as statically determinate, measurement and adjustment of the applied force are straightforward. To extrude an upper central incisor, a force of 20cN is typically applied; for extrusion of an upper canine, 25cN is generally adequate.⁹

The versatility of abutments or plates with brackets is a great advantage when a force adjustment is needed during extrusion to prevent root damage to the adjacent teeth or to correct the position of the erupted tooth. Different wires can be



Fig. 3 Tandem implants: direct anchorage. A. 53-year-old male patient with retained and dystopic upper left third molar. B. Two mini-implants coupled with Beneplate; preactivated .031" stainless steel wire used to create extrusive force. C. Patient after seven months of third-molar extrusion.

Fig. 4 Single implant: indirect molar anchorage. A. 13-year-old female patient with impacted upper canines. Molar tipping and intrusion prevented during canine extrusion by using transpalatal bar formed from .031" stainless steel wire, pre-welded to implant abutment; extrusive forces provided by two preactivated .016" × .022" TMA sectional wires inserted into additional lingual tubes on molar bands. B. Patient after four months of canine extrusion.



sequentially ligated to the abutment for this purpose (Fig. 6).

Discussion

The risk of root resorption caused by impacted and displaced teeth has long been recognized.¹⁵⁻¹⁹ Successful extrusion and alignment of such teeth requires efficient mechanics with minimal side effects. Although vertical tooth movement with heavy forces further increases the possibility of root resorption,²⁰ the mechanics illustrated in this article are statically determinate, ensuring clinical control by means of a simple technique.

A stable anchorage unit is needed to prevent unwanted intrusive side effects during extrusion of the impacted tooth.⁴ Skeletal anchorage using mini-implants has been shown to provide reliable

anchorage in various clinical situations.^{21,22} Side effects can be reduced by avoiding heavy force loads, as long as the anchorage unit remains stable. Using the selective mechanics shown in this article, the time needed to wear full appliances can be minimized, which also reduces the likelihood of decalcification.

In a limited study performed in our clinic, we used the mechanics described here in 42 cases (12 direct anchorage, 30 indirect anchorage) involving 53 teeth. Fifty-two of the teeth (98.1%) were successfully extruded, with 53 of 56 mini-implants (94.6%) remaining stable in the anterior palate. Due to its superior bone quality and quantity,²³ the anterior palate has demonstrated lower miniscrew failure rates (5.6%) compared to the alveolar ridge (16.4%).^{13,24,25} Another positive aspect of using the anterior palate as the insertion site is that the anchorage construction and most of the extrusion

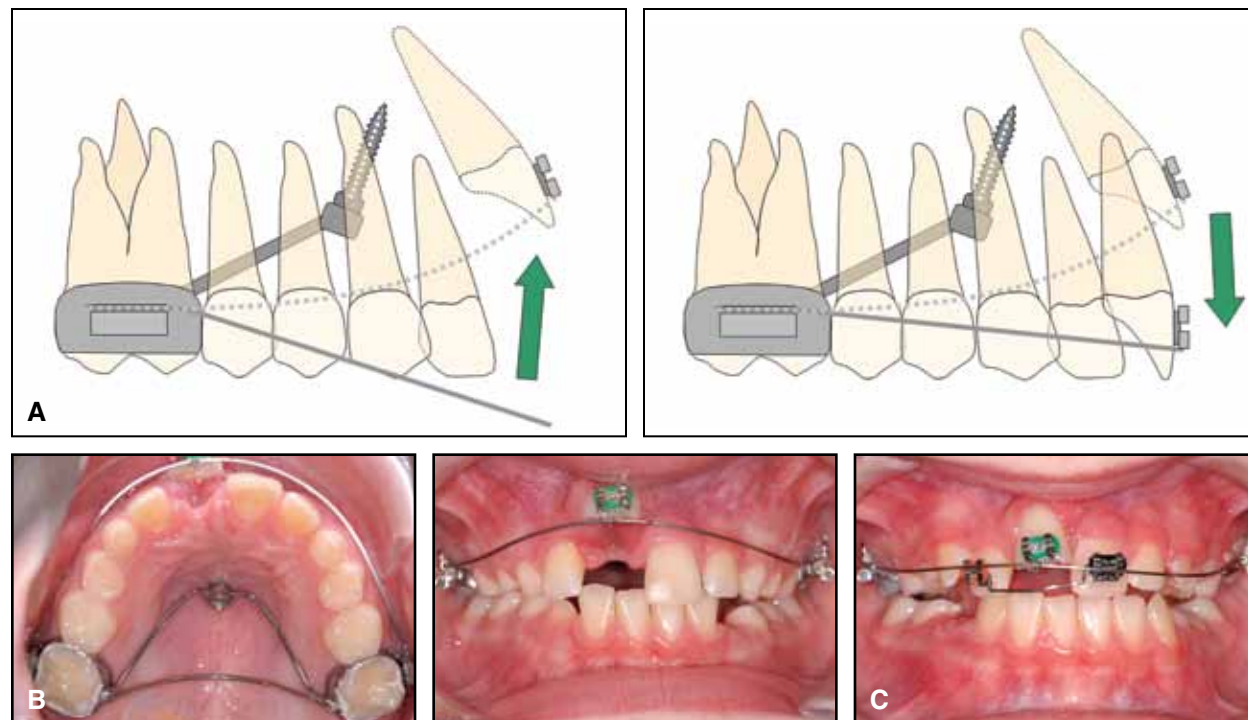


Fig. 5 Single implant: indirect molar anchorage. **A.** Preactivated .016" × .022" TMA extrusion arch inserted into first-molar auxiliary tubes. **B.** 8-year-old male patient with buccally displaced and impacted upper central incisor fitted with .043" stainless steel "triangular transpalatal arch" connecting molar bands and mini-implant. **C.** Patient after nine months of incisor extrusion.

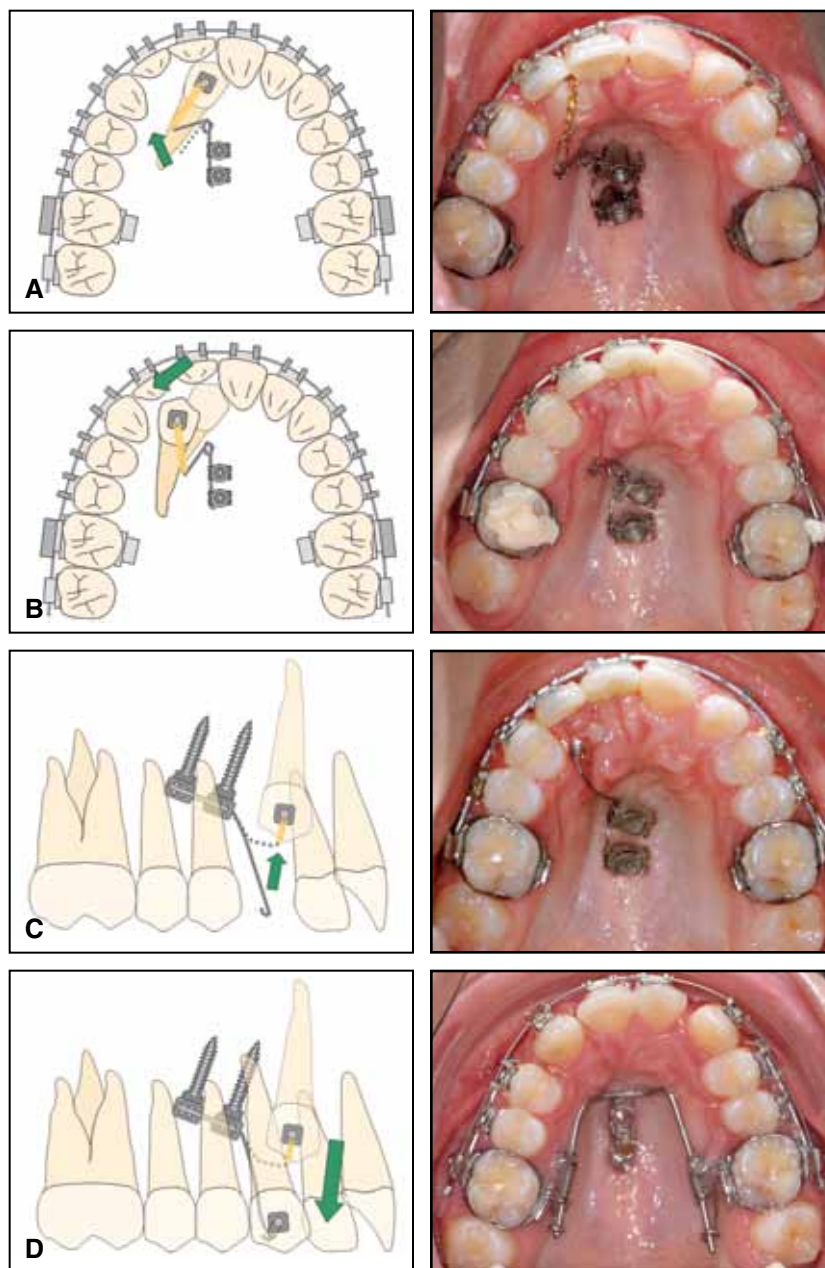


Fig. 6 Variation of force vector in 14-year-old female patient with palatally impacted upper right canine and buccally erupting upper left canine. Position of right canine had led to upper right central and lateral incisor root resorption and subsequent extraction of those teeth. **A.** Two mini-implants with bracket abutments coupled by .016" × .022" TMA sectional wire placed in anterior palate; first wire activated to create distal traction, preventing further root damage to incisors. **B.** Patient after three months of distal canine traction. **C.** Second sectional wire placed to create extrusive force (as in Figure 2). **D.** Patient after 20 months of treatment. Left central and lateral incisors moved to central incisor positions; upper right and left canines aligned in arch; mini-implants refitted for molar distalization with Beneslider^{*14} for dental Class II correction.

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appliance are nearly invisible extraorally.

Since mini-implants inserted in the anterior palate do not interfere with the dental roots, they can be used in the mixed dentition. In cases with severely palatally displaced teeth, however, radiographic location is always advisable prior to implant insertion. Adjusting the line of force during the extrusion phase is crucial to prevent root damage.

The prefabricated components of the Benefit/Beneplate system allow fabrication without welding or soldering. In many cases, the appliance can be fitted at the chair. Standard constructions providing either direct or indirect anchorage are now available. Using the appropriate interchangeable abutment, the mechanics can be easily adapted to each patient's biomechanical requirements.

REFERENCES

- Hattab, F.N.; Rawashdeh, M.A.; and Fahmy, M.S.: Impaction status of third molars in Jordanian students, *Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod.* 79:24-29, 1995.
- Bishara, S.E.: Clinical management of impacted maxillary canines, *Semin. Orthod.* 4:87-98, 1998.
- Becker, A.: *The Orthodontic Treatment of Impacted Teeth*, Martin Dunitz, Ltd., London, 1998.
- Kokich, V.G. and Mathews, D.P.: Surgical and orthodontic management of impacted teeth, *Dent. Clin. N. Am.* 37:181-204, 1993.
- Costa, A.; Raffaini, M.; and Melsen, B.: Miniscrews as orthodontic anchorage: A preliminary report, *Int. J. Adult Orthod. Orthog. Surg.* 13:201-209, 1998.
- Melsen, B. and Costa, A.: Immediate loading of implants used for orthodontic anchorage, *Clin. Orthod. Res.* 3:23-28, 2000.
- Wilmes, B.: Fields of application of mini-implants, in *Innovative Anchorage Concepts: Mini-Implants in Orthodontics*, ed. B. Ludwig, S. Baumgaertel, and S.J. Bowman, Quintessence, Berlin, 2008.
- Kanomi, R.: Mini-implant for orthodontic anchorage, *J. Clin. Orthod.* 31:763-767, 1997.
- Wilmes, B. and Drescher, D.: Vertical periodontal ligament distraction—a new method for aligning ankylosed and displaced canines, *J. Orofac. Orthop.* 70:213-223, 2009.
- Wilmes, B. and Drescher, D.: A miniscrew system with interchangeable abutments, *J. Clin. Orthod.* 42:574-580, 2008.
- Wilmes, B.; Rademacher, C.; Olthoff, G.; and Drescher, D.: Parameters affecting primary stability of orthodontic mini-implants, *J. Orofac. Orthop.* 67:162-174, 2006.
- Wilmes, B.; Ottenstreuer, S.; Su, Y.Y.; and Drescher, D.: Impact of implant design on primary stability of orthodontic mini-implants, *J. Orofac. Orthop.* 69:42-50, 2008.
- Wilmes, B.; Drescher, D.; and Nienkemper, M.: A miniplate system for improved stability of skeletal anchorage, *J. Clin. Orthod.* 43:494-501, 2009.
- Wilmes, B. and Drescher, D.: Application and effectiveness of the Beneslider: A device to move molars distally, *World J. Orthod.* 11:331-340, 2010.
- Alqerban, A.; Jacobs, R.; Lambrechts, P.; Loozen, G.; and Willems, G.: Root resorption of the maxillary lateral incisor caused by impacted canine: A literature review, *Clin. Oral Investig.* 13:247-255, 2009.
- Amlani, M.S.; Inocencio, F.; and Hatibovic-Kofman, S.: Lateral incisor root resorption and active orthodontic treatment in the early mixed dentition, *Eur. J. Paediat. Dent.* 8:188-192, 2007.
- Arens, D.E.: An alternative treatment for the severely resorped maxillary lateral incisor: A sequela of ectopic eruption, *J. Endod.* 21:95-100, 1995.
- Ericson, S. and Kurol, J.: Incisor resorption caused by maxillary cuspids. A radiographic study, *Angle Orthod.* 57:332-346, 1987.
- Ericson, S. and Kurol, J.: Incisor root resorptions due to ectopic maxillary canines imaged by computerized tomography: A comparative study in extracted teeth, *Angle Orthod.* 70:276-283, 2000.
- Han, G.; Huang, S.; Von den Hoff, J.W.; Zeng, X.; and Kuijpers-Jagtman, A.M.: Root resorption after orthodontic intrusion and extrusion: An intraindividual study, *Angle Orthod.* 75:912-918, 2005.
- Yao, C.C.; Lai, E.H.; Chang, J.Z.; Chen, I.; and Chen, Y.J.: Comparison of treatment outcomes between skeletal anchorage and extraoral anchorage in adults with maxillary dento-alveolar protrusion, *Am. J. Orthod.* 134:615-624, 2008.
- Upadhyay, M.; Yadav, S.; and Patil, S.: Mini-implant anchorage for en-masse retraction of maxillary anterior teeth: A clinical cephalometric study, *Am. J. Orthod.* 134:803-810, 2008.
- Kang, S.; Lee, S.J.; Ahn, S.J.; Heo, M.S.; and Kim, T.W.: Bone thickness of the palate for orthodontic mini-implant anchorage in adults, *Am. J. Orthod.* 131(4 suppl):S74-81, 2007.
- Stanford, N.: Mini-screws success rates sufficient for orthodontic treatment, *Evid. Based Dent.* 12:19, 2011.
- Schätzle, M.; Männchen, R.; Zwahlen, M.; and Lang, N.P.: Survival and failure rates of orthodontic temporary anchorage devices: A systematic review, *Clin. Oral Impl. Res.* 20:1351-1359, 2009.