Alberto Caprioglio, DDS[1]

Lea Siani, DDS[2]

Claudia Caprioglio, DDS[3]

GUIDED ERUPTION OF PALATALLY IMPACTED CANINES THROUGH COMBINED USE OF 3-DIMENSIONAL COMPUTERIZED TOMOGRAPHY SCANS AND THE EASY CUSPID DEVICE

The permanent maxillary canine has a high incidence of impaction. In the clinical treatment of impaction, the first problem is diagnosis and localization. The new diagnostic 3-dimensional systems shown in this article provide valid support in understanding anatomic connections and planning the movements needed for orthodontic correction. Thus, the clinician can reduce the incidence of iatrogenic damage of adjacent structures. This article reviews several biomedical systems for guided eruption of palatally impacted canines and discusses a new device for guided eruption of the surgically disimpacted tooth. This device, called Easy Cuspid, is designed to reduce recognized problems with reaction forces through a simple method. A clinical case of bilateral impaction of the permanent maxillary canines shows the application of the diagnostic method and the biomechanical system, Easy Cuspid. World J Orthod 2007;8:109–121.

[1]Associate Professor, Department of Paediatric Dentistry, School of Dentistry, University of Insubria, Varese, Italy.
[2]Researcher, International Center for Continuing Education in Dentistry, Pavia, Italy.
[3]Research Director, International Center for Continuing Education in Dentistry, Pavia, Italy.

CORRESPONDENCE
Dr Alberto Caprioglio
Via San Zeno, 1
27100 Pavia
Italy
E-mail: ac.caprioglio@tin.it

The maxillary canines are a particularly important element inside the oral cavity, not only for esthetic reasons, but for their functional role during lateral disocclusion movements and molar protection. Consequently, the dental literature has paid close attention to the diagnosis of impacted canines, their location in comparison to the roots of adjacent teeth, and both the treatment plan and the development of new disimpaction and alignment devices. A previous study[1] showed it was possible to confirm the coronal position of impacted canines through conventional diagnostic techniques in about 51% of the cases; the position of the apex was confirmed in only about 29% of the cases. It is therefore necessary to establish a safe and predictable method of dealing with impacted canines.

LITERATURE REVIEW

After defining the position of the impacted canines and, particularly after identifying those that are palatally impacted, there is a wide choice of techniques to debride and guide the canine into the maxillary arch. One traditional approach has been the use of a round steel wire and an elastic tie. This approach has the inherent disadvantage

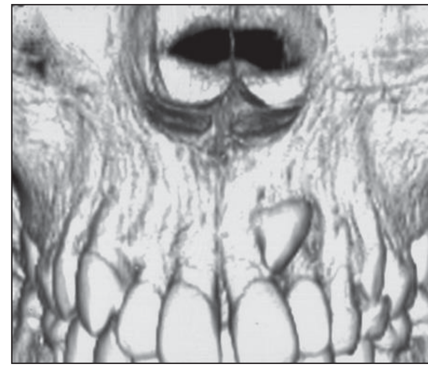


Fig 8 *(right)* Case 8. Three-dimensional CT scan shows labial impaction of the maxillary left canine. Note the proximity with the root of the lateral and central incisors.

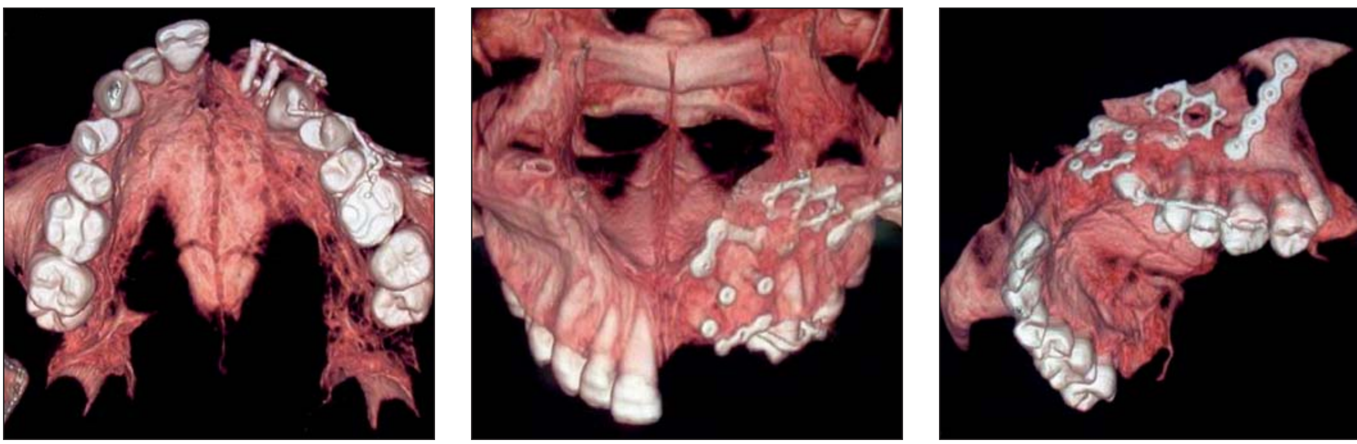


Fig 9 *(below)* Case 9. Three-dimensional CT scans show labial impaction of the maxillary left canine and allow identification of the blood vessels.

diately obvious that the crown of the maxillary left canine is in close vestibular contact with the root of the lateral incisor, while the root of the impacted tooth is close to the apex of the first premolar. After reviewing these images, it is clear that poorly executed traction could produce iatrogenic damages to the lateral incisor, especially if the traction was executed palatally, and to the first premolar, if the traction was vestibularly executed in a vertical direction.

Analysis of Fig 2 demonstrates the importance of the 3-dimensional CT scan. From a medicolegal standpoint, the views define damage that has occurred at the root level of adjacent teeth before application of any kind of traction.

Finally, as seen above in bilateral impactions, the clinician can also obtain a great amount of information on the debridement priority according to tooth location, to avoid iatrogenic damage and delay during therapy. Case 3 (Fig 3) shows the importance of correct debridement and traction of the maxillary right canine in the palatodistal direction first; the left canine was then moved by distally directed palatal traction, to move it away from the roots of both central and lateral incisors.

In case 4 (Fig 4), both canines are palatally impacted, but they do not interfere with each other. Case 5 (Fig 5) shows both canines are palatally impacted, but the apicocoronal axes are more inclined in a mesial direction. Thus, the authors proceeded to debride the left canine before the right, because the left canine required traction toward the contralateral side and space to move.

In other cases, both canines may be impacted on the vestibular side; in this situation, it is less important to decide which of the 2 to treat first. However, it is more important to visualize their position with the proximal teeth, especially the lateral incisors on the same side, as shown in cases 6 (Fig 6) and 7 (Fig 7). Proximity may also involve other teeth, such as the homolateral central incisors, as seen in case 8 (Fig 8).

From the 3-dimensional CT diagnostic technique, it is possible to deduce more information about the optimal surgical of allowing unwanted rotations and poor directional control. In addition, the reciprocal torque these rotations apply to the molar segment needs to be compensated through the use of a palatal bar that reinforces the available anchorage, often requiring an extension to the premolars.

Several different approaches to solve this problem have been proposed. In 1979, Jacoby[2] presented the Ballista Spring, a vestibular attachment device that could apply a palatally directed extrusion force to the tooth through a crossover lever analogous to a medieval “ballista”. Over time, different authors have proposed changes to this original concept, looking to improve its effectiveness, eliminate undesired side effects, simplify the procedures, and optimize the results.

Lazzati et al[3] proposed a device intended to resist the reaction force at the level of the molars by screwing the ballista directly to the basic rectangular steel archwire for anchorage. Kornhauser et al[4] took advantage of the crossover lever concept by bending a vertical loop directly on a round continuous archwire, as an auxiliary to the main arch, but this did not solve the problem linked to the rotation of the auxiliary arch. Crescini[5] chose to use a double archwire with a full-size main arch and a second arch bent to accept the elastic traction with directional flexibility.

Others have proposed using removable appliances as anchorage. For example, McDonald and Yap[6] and Darendeliler and Friedli[7] chose to exploit a maxillary plate, the former for traction with elastics, and the latter used magnets for the same purpose. Orton et al[8] proposed the use of a mandibular plate to hook to the chain emerging from the maxillary impacted tooth.

Magnusson[9] chose to solder a 0.016-inch β-titanium spring to a 0.016 × 0.022-inch stainless steel sectional archwire to fit into the 0.018-inch slot of the brackets of the homolateral premolars. However, this anchorage was not sufficient in cases where a significant movement of the impacted tooth was needed, and the support of a palatal bar was necessary. Terry and Thomson[10] proposed a lever arm composed of a resilient wire rolled around a steel tube that contained the main archwire, but this appeared to be less stable than similar systems. Ross[11] looked to solve the problem of the decay of the applied force by using a nickel-titanium (NiTi) coil spring of a Jones jig (American Orthodontics, Sheboygan, WI, USA), made shorter and rolled around the rectangular main archwire.

Some systems, while biomechanically favorable due to the maintenance of the anchorage and control of side effects, are penalized by the complexity required for their planning and/or execution. Such is the case with the statically defined appliance proposed by Patel et al[12] and the cantilever palatal lever proposed by Fischer et al.[13]

More recent proposals by Kalra[14] (K-9 spring) and Bowman and Carano[15] (Kilroy spring) do not overcome the mechanical problems previously identified. For instance, the K-9 spring[14] does not exploit the anchorage provided by the continuous archwire, and the lever rotation problem is only partially solved by replacing a rectangular wire with a round one and β-titanium alloy (TMA) for stainless steel. The Kilroy spring[15] is a spring bent according to whether the impaction is palatal or vestibular, using a rectangular main arch as anchorage. It needs frequent inspections because of its large size and it runs the risk of applying a progressive coronopalatal torque to the adjacent dental units on which the reaction force is shared.

Finally, Oppenhuizen[16] proposed a lever composed of a steel 0.018-inch round arch inserted into the slot of the brackets bonded to the incisor group with a NiTi or TMA stabilization rectangular arch. In this case, the problem concerning side effects is moved from the back to the front, always in terms of coronopalatal torque.

Thus, all the designs and modifications have been inspired by the desire to solve similar problems linked to an original lever concept. Based on these opinions and the authors’ own experience, it is suggested that an ideal device for the extrusion of palatal impacted canines should have:

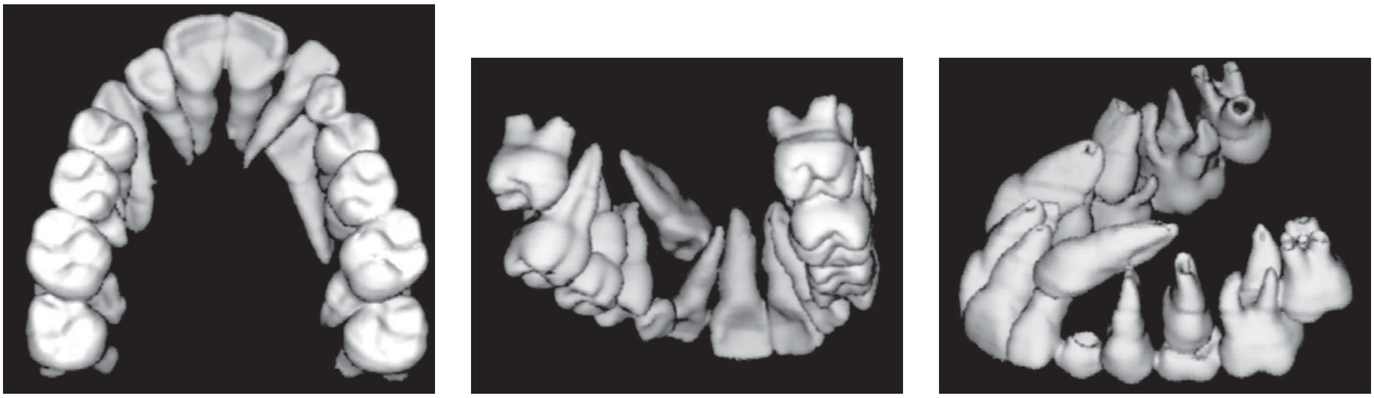


Fig 1 Case 1. Three-dimensional CT scans show labial impaction of maxillary left canine.

- Rigid and extended anchorage for control of side effects
- Spatially concentrated and temporally continuous elasticity
- Force with vector flexibility able to avoid obstacles along the way
- Adequate control of force intensity, ideally equal to 4 to 5 ounces
- Planning and execution simplicity

This article introduces a technique of disimpaction through a new device (Easy Cuspid), conceived not only to simplify the fabrication procedures and avoid some of the identified problems, but also to couple it to the new diagnostic technology of the 3-dimensional computerized tomography (CT) scan.

3-DIMENSIONAL CT SCAN

The use of the 3-dimensional CT scan for diagnostic purposes in orthodontics represents a new and controversial topic. According to data collected by the authors,[1] the main examination to localize the crown of an impacted canine is the panoral radiograph in combination with the execution of good intraoral radiographs. This technique is reliable in about 60% of cases; it does not require the patient to be exposed to further radiation and it is the one most commonly used by dentists. Moreover, in the remaining 40% of cases, this method suggests the position of the impacted tooth and indicates if further radiographic inquiries are necessary.

Thus, a 3-dimensional CT would not be necessary if the position of the impacted canine could be defined *(1)* by the presence of the canine eminence or ability to palpate the crown palatally; *(2)* according to the position of the maxillary lateral incisor crown (when the lateral incisor is retroclined, the canine will be palatal, and when the lateral incisor is proclined, the canine will be vestibular); and *(3)* through conventional radiographic techniques (panoral, occlusal, intraoral executed according to Clark's rule, and lateral cephalogram).

A 3-dimensional CT scan is necessary if *(1)* none or only 1 of the previous conditions is fulfilled; *(2)* the information derived from the previous conditions is discordant; *(3)* the clinician suspects radicular resorption of teeth adjoining the impacted tooth (a 3-dimensional CT scan can be used to visualize the extent of the damage); and *(4)* there is bilateral canine impaction and priority for debridement needs to be established.

In short, acknowledging the further exposure to x-rays, the cost-advantage ratio for each case has to be established. It is preferable to submit the patient to greater exposure to x-rays than to the iatrogenic risks of an incorrect orthodontic-surgical treatment.[1]

The authors can assert that the images from a 3-dimensional CT scan are numerous and extremely clear, for both the absolute position of the impacted canine and the apices of adjacent teeth that could be at risk from the impaction. For instance, in case 1 (Fig 1), it is imme-

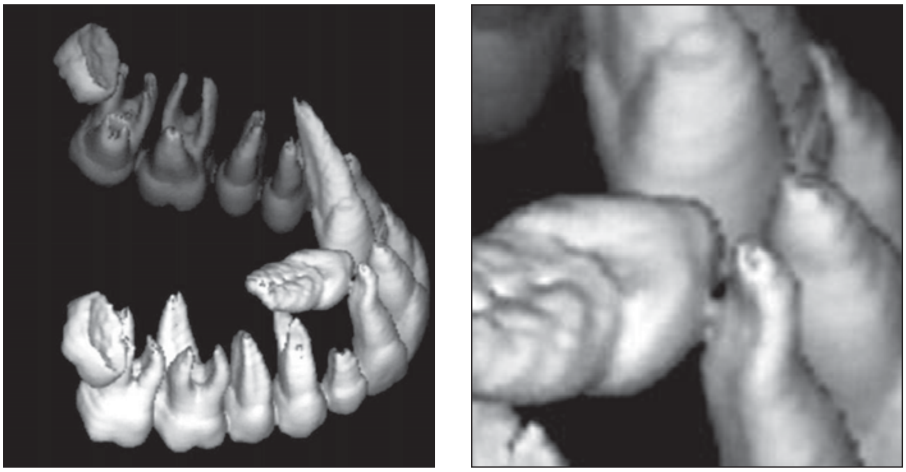


Fig 2 Case 2. Three-dimensional CT scans show palatal impaction of maxillary right canine. Note the root resorption of the maxillary right lateral incisor.

Fig 3 Case 3. Three-dimensional CT scan shows palatal impaction of the maxillary right and left canines.

Fig 4 Case 4. Three-dimensional CT scan shows palatal impaction of the maxillary right and left canines. Both canines can be extruded at the same time without any interference.

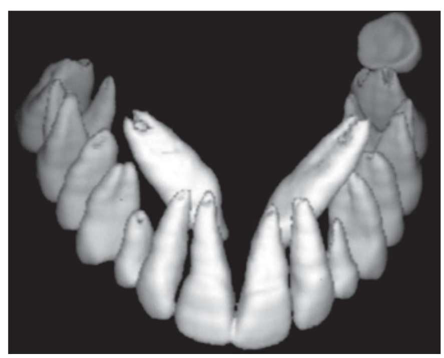


Fig 5 Case 5. Three-dimensional CT scan shows palatal impaction of the maxillary right and left canines.

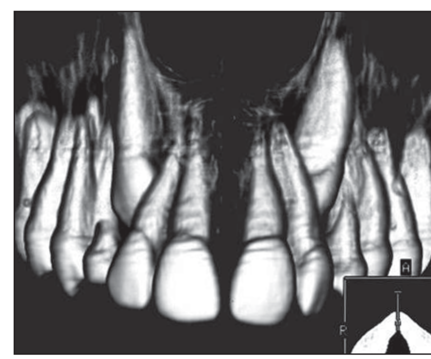


Fig 6 Case 6. Three-dimensional CT scan shows labial impaction of the maxillary right and left canines.

Fig 7 Case 7. Three-dimensional CT scans show labial impaction of the maxillary right canine and palatal impaction of the left canine.

Fig 8 *(right)* Case 8. Three-dimensional CT scan shows labial impaction of the maxillary left canine. Note the proximity with the root of the lateral and central incisors.

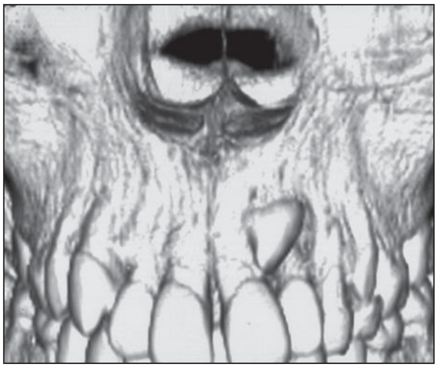
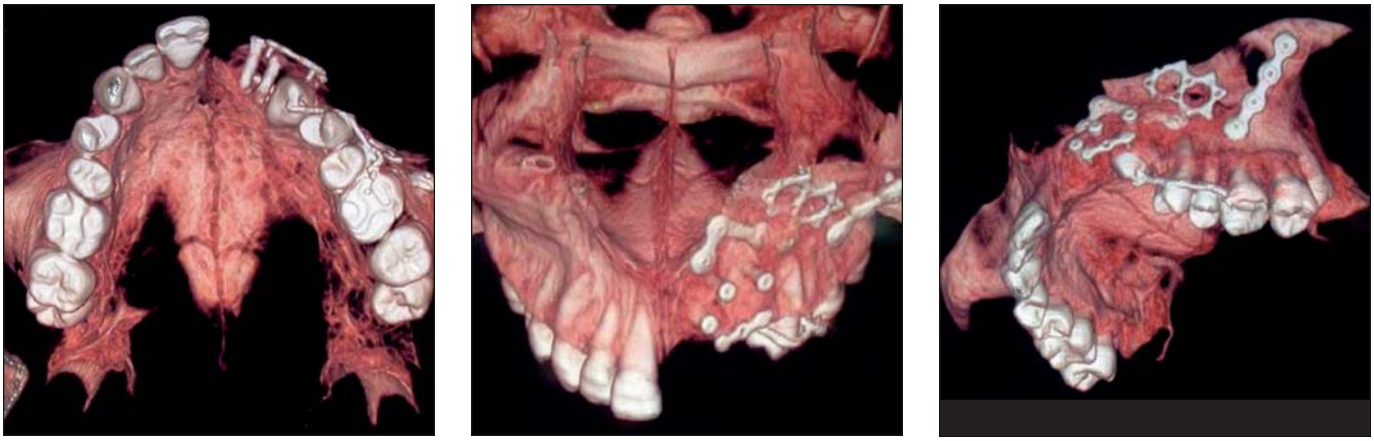


Fig 9 *(below)* Case 9. Three-dimensional CT scans show labial impaction of the maxillary left canine and allow identification of the blood vessels.



diately obvious that the crown of the maxillary left canine is in close vestibular contact with the root of the lateral incisor, while the root of the impacted tooth is close to the apex of the first premolar. After reviewing these images, it is clear that poorly executed traction could produce iatrogenic damages to the lateral incisor, especially if the traction was executed palatally, and to the first premolar, if the traction was vestibularly executed in a vertical direction.

Analysis of Fig 2 demonstrates the importance of the 3-dimensional CT scan. From a medicolegal standpoint, the views define damage that has occurred at the root level of adjacent teeth before application of any kind of traction.

Finally, as seen above in bilateral impactions, the clinician can also obtain a great amount of information on the debridement priority according to tooth location, to avoid iatrogenic damage and delay during therapy. Case 3 (Fig 3) shows the importance of correct debridement and traction of the maxillary right canine in the palatodistal direction first; the left canine was then moved by distally directed palatal traction, to move it away from the roots of both central and lateral incisors.

In case 4 (Fig 4), both canines are palatally impacted, but they do not interfere with each other. Case 5 (Fig 5) shows both canines are palatally impacted, but the apicocoronal axes are more inclined in a mesial direction. Thus, the authors proceeded to debride the left canine before the right, because the left canine required traction toward the contralateral side and space to move.

In other cases, both canines may be impacted on the vestibular side; in this situation, it is less important to decide which of the 2 to treat first. However, it is more important to visualize their position with the proximal teeth, especially the lateral incisors on the same side, as shown in cases 6 (Fig 6) and 7 (Fig 7). Proximity may also involve other teeth, such as the homolateral central incisors, as seen in case 8 (Fig 8).

From the 3-dimensional CT diagnostic technique, it is possible to deduce more information about the optimal surgical

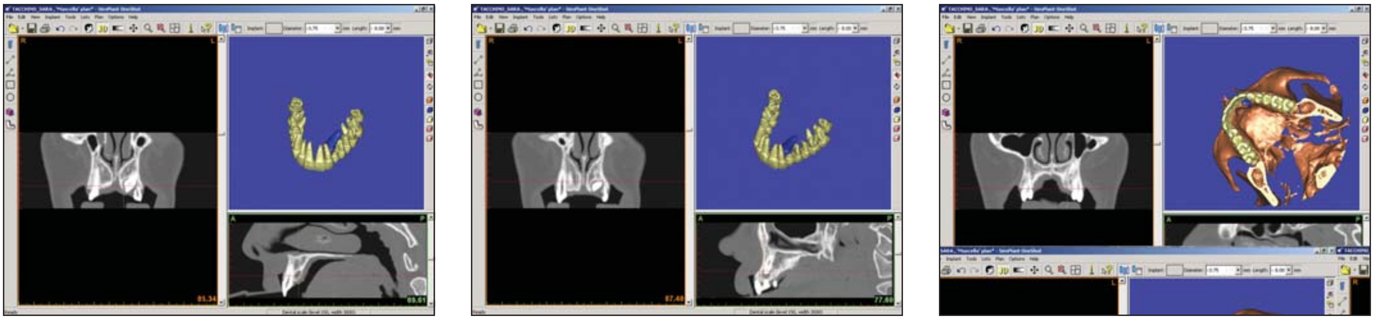
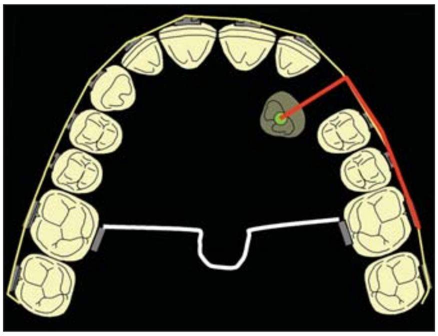


Fig 10 Case 10. Visualization of the images provided by a dedicated software.



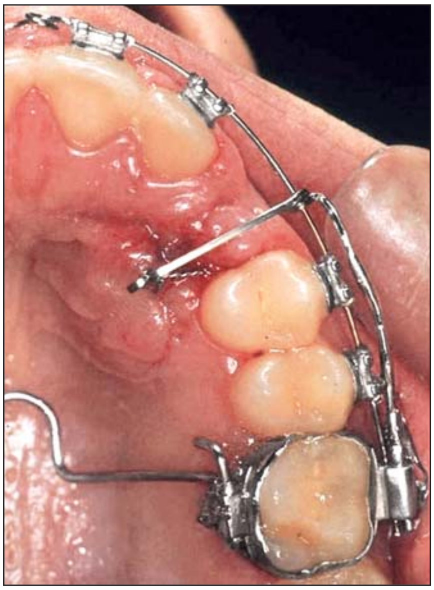
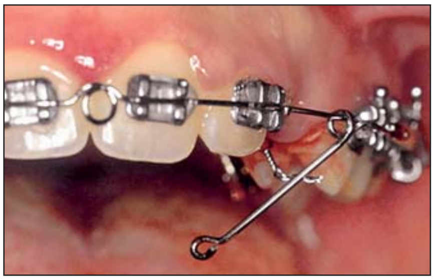


Fig 11 *(left)* Basic elements of the Easy Cuspid.

Fig 12 *(right)* Intraoral photograph, maxillary occlusal view, shows details of an Easy Cuspid inserted into its site and linked to the chain emerging from the surgically debrided tooth.



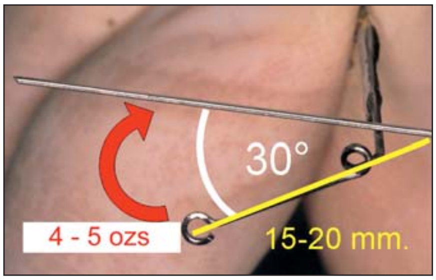


Fig 13 *(left)* Frontal view shows details of an Easy Cuspid inserted into its site and not yet linked to the chain emerging from the surgically debrided tooth.

Fig 14 *(right)* Basic elements of the force system used.

Fig 15 Model of a molar band with 3 vestibular tubes.

Fig 16 Easy Cuspid after the welding phase.

Fig 17 Easy Cuspid, with modified terminal, inserted into the tubes of the molar band.

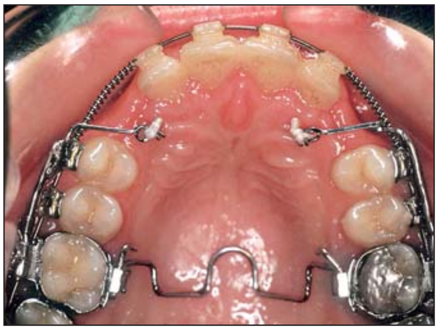


Fig 18 Maxillary occlusal view of a bilateral Easy Cuspid.

Fig 19 Left lateral view of crossover on the mandibular interproximal point.

Fig 20 Comparison between an Easy Cuspid prepared for standard cases and those requiring extraction.

approach since radiologists can localize the blood vessels, as shown in Fig 9. The clinician can also obtain other types of images with dedicated software, such as the SimPlant (Materialize, Leuven, Belgium).

On the basis of standardized files (.DICOM), the clinician can evaluate different cuts and perspectives, and have a 3-dimensional vision for each. The 3-dimensional model can be turned in every direction to better see the proximity between the anatomic structures. Moreover, it is possible to put different tissues in view (mucosa, bone, erupted and impacted teeth), identifying them with different colors and freezing the most important cuts, as shown in Fig 10.

MATERIAL AND METHODS

For the case shown here, the authors chose to obtain anchorage from banding the entire maxillary arch, tied together by a 0.018-inch round stainless steel archwire and by a removable palatal bar. The palatal bar is bent to give coronovestibular torque to resist the coronopalatal forces, following occlusal traction of the homolateral canine (Figs 11 and 12).

The appliance used was the Jones jig, which was originally conceived for distalization of the maxillary molars. The Jones jig was modified by removing the spring, cutting the steel arm in the middle of its length, and soldering a 0.017 × 0.025-inch rectangular steel wire on this arm. This new device has been named Easy Cuspid.[17]

The helices were bent to give elasticity to the system, to obtain the crossover from vestibular to palatal, to give greater stability to the system, and to keep adequate tension on the ligature between the chain emerging from the impacted canine and the Easy Cuspid.[17] Further, based on the literature and on the fact that the length of the active arm is 15 to 20 mm, and assuming the corner angle formed by the ballista is 30 degrees, a traction force of 4 to 5 ounces should be applied (Figs 13 and 14). However, to obtain that force, it is necessary to have a system in which the maxillary first molar bands are prepared with triple tubes. The triple tubes permit insertion of the main arch into the principal tube, and the Easy Cuspid in the accessory tube and the tube prepared to contain the extraoral traction terminal (Figs 15 to 17).

In the most complex cases, activations are carried out at intervals of 2 to 3 weeks over a 3- to 4-month period. This modular system is suitable for unilateral as well as bilateral impactions. In the case of bilateral impaction, a compensatory bend to the removable transpalatal bar at both terminals will act at the molar level (Fig 18). Additional attention has to be given to the bend of the first helix for the palatal crossover. This bend must correspond with the mandibular interproximal space for the patient's comfort and for easier clinical management (Fig 19).

In an impaction case that also requires extractions, traditional methods are followed to prepare space for the canine and to close remaining extraction sites; however, additional modifications to the Easy Cuspid will be necessary because the vestibular arm will need a reduced size to fit the length of the maxillary arch, about half of the original length (Fig 20).

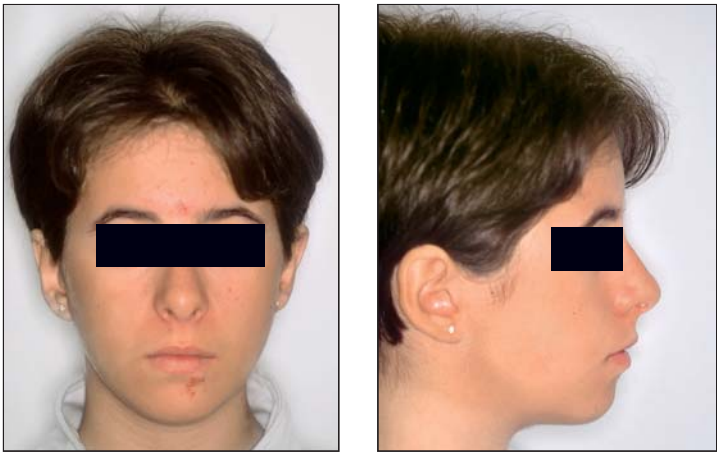


Fig 21 Patient PM, 12 years 1 month of age. Pretreatment facial photographs.

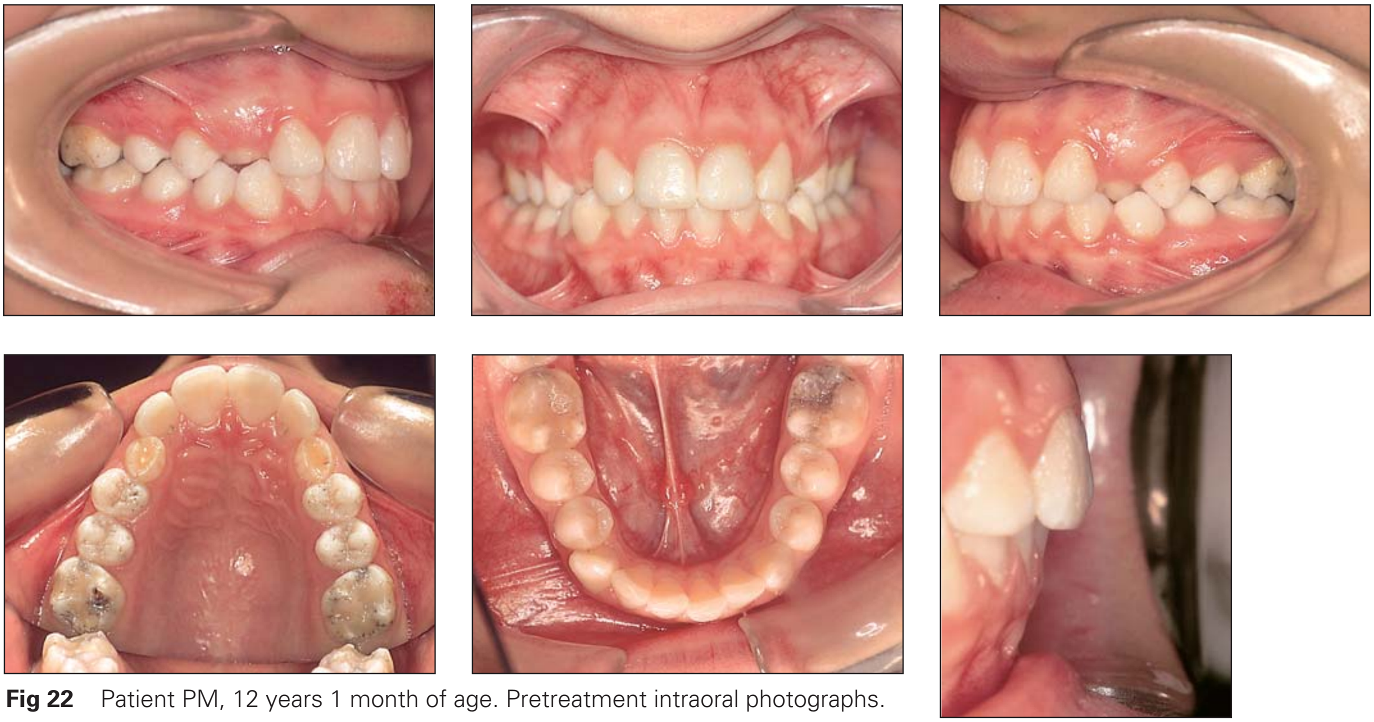


Fig 22 Patient PM, 12 years 1 month of age. Pretreatment intraoral photographs.

CLINICAL CASE

Patient PM (Fig 21), a female 12 years 1 month of age, was seen in February 2002 because of the persistence in the maxillary arch of primary canines on the right and left sides, and the noneruption of the corresponding permanent canines.

During the diagnostic analysis (Fig 22), the problem was not only explained to the patient and her parents, but they were also informed of the presence of a generalized form of amelogenesis imperfecta in the permanent dentition. Panoral and lateral cephalograms (Figs 23 and 24) show the bilateral impaction of the maxillary canines.

A 3-dimensional CT scan was used to better view the 3-dimensional localization of both impacted teeth and the connections with anatomic adjacent structures, to assess the priority of

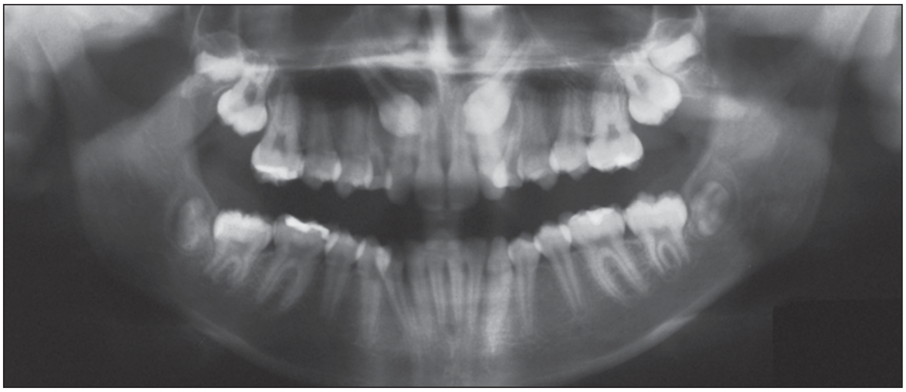


Fig 23 Patient PM, 12 years 1 months of age. Pretreatment panoral radiograph.

Fig 24 Patient PM, 12 years 1 month of age. Pretreatment lateral cephalogram.

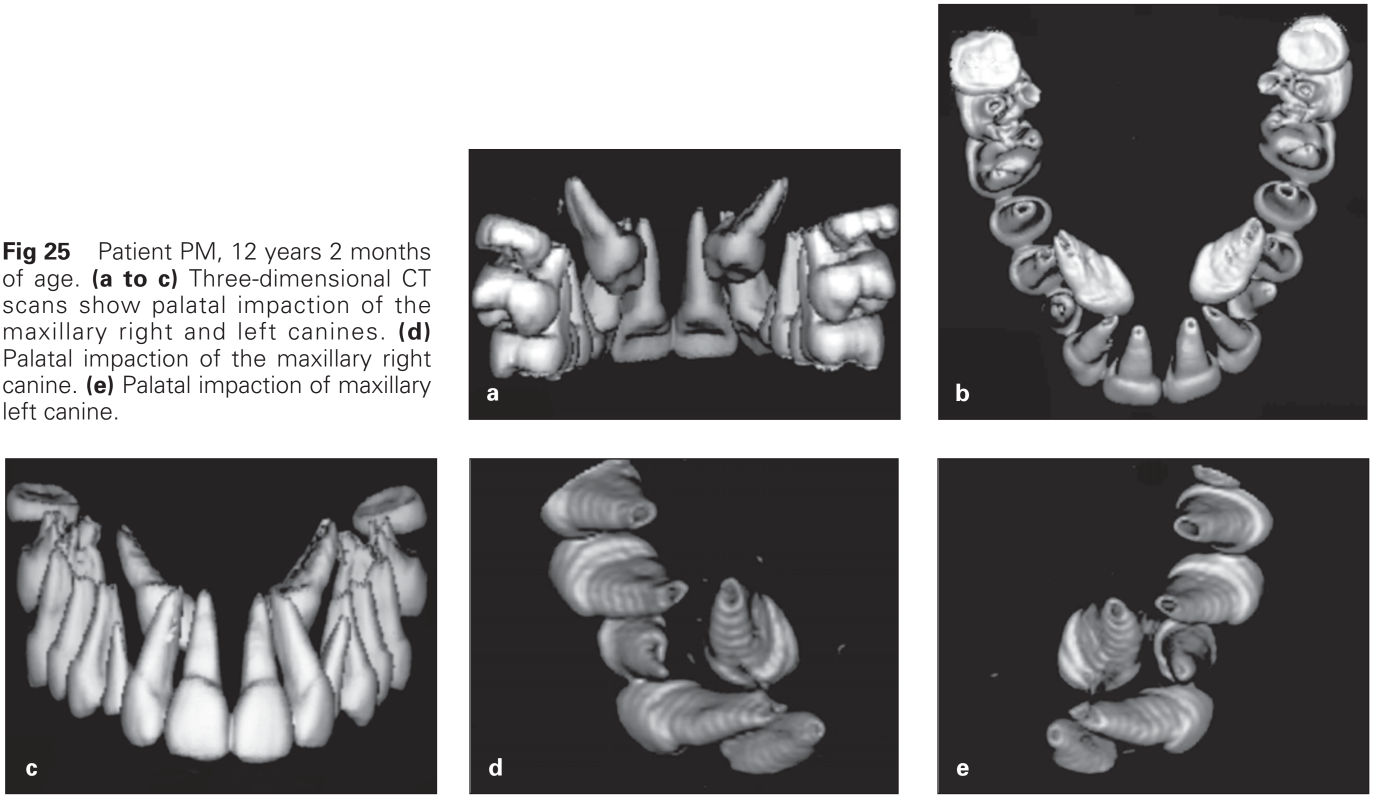


Fig 25 Patient PM, 12 years 2 months of age. **(a to c)** Three-dimensional CT scans show palatal impaction of the maxillary right and left canines. **(d)** Palatal impaction of the maxillary right canine. **(e)** Palatal impaction of maxillary left canine.

debridement, and to aid the surgical and mechanical planning of the case. The scan provided significant images (Fig 25) that show the palatal impaction of both permanent maxillary canines.

The optimal surgical access to both teeth was from the palatal. The maxillary left canine was debrided first, then the maxillary right canine. The occlusodistal direction of traction was used to remove the crowns from the roots of both permanent lateral incisors.

In April 2002, the authors bonded the maxillary arch and inserted a palatal bar on the maxillary first molars; space was then prepared for the permanent

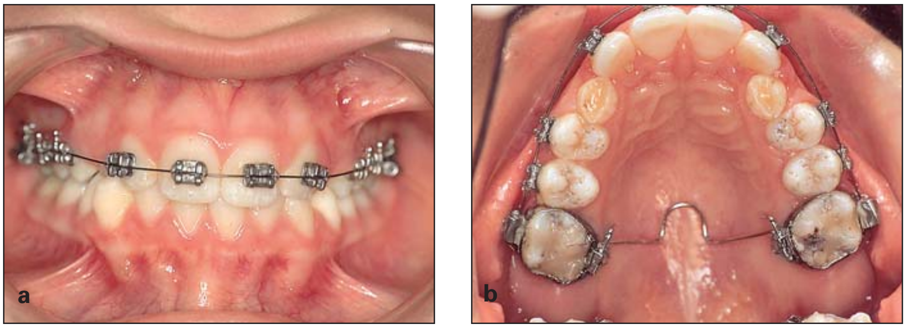


Fig 26 (a and b) Patient PM, 12 years 3 months of age.

Fig 27 *(below)* **(a to c)** Patient PM, 12 years 9 months of age.

Fig 28 *(left)* Patient PM, 12 years 10 months of age.

Fig 29 *(right)* Patient PM, 12 years 11 months of age.

Fig 30 **(a to c)** Patient PM, 13 years 2 months of age.

canines (Fig 26). After aligning and leveling the maxillary arch, the authors proceeded with the surgical debridement of the left canine. The point chosen for the crossover was connected to the interproximal space between the antagonist teeth, and not connected to the canine, to increase the possibilities for modification and the patient's comfort (Fig 27). In October 2002, the left canine erupted; the disimpaction of the right canine (Fig 28) was carried out in December 2002, while the left canine was left alone until the eruption of the right canine (Fig 29).

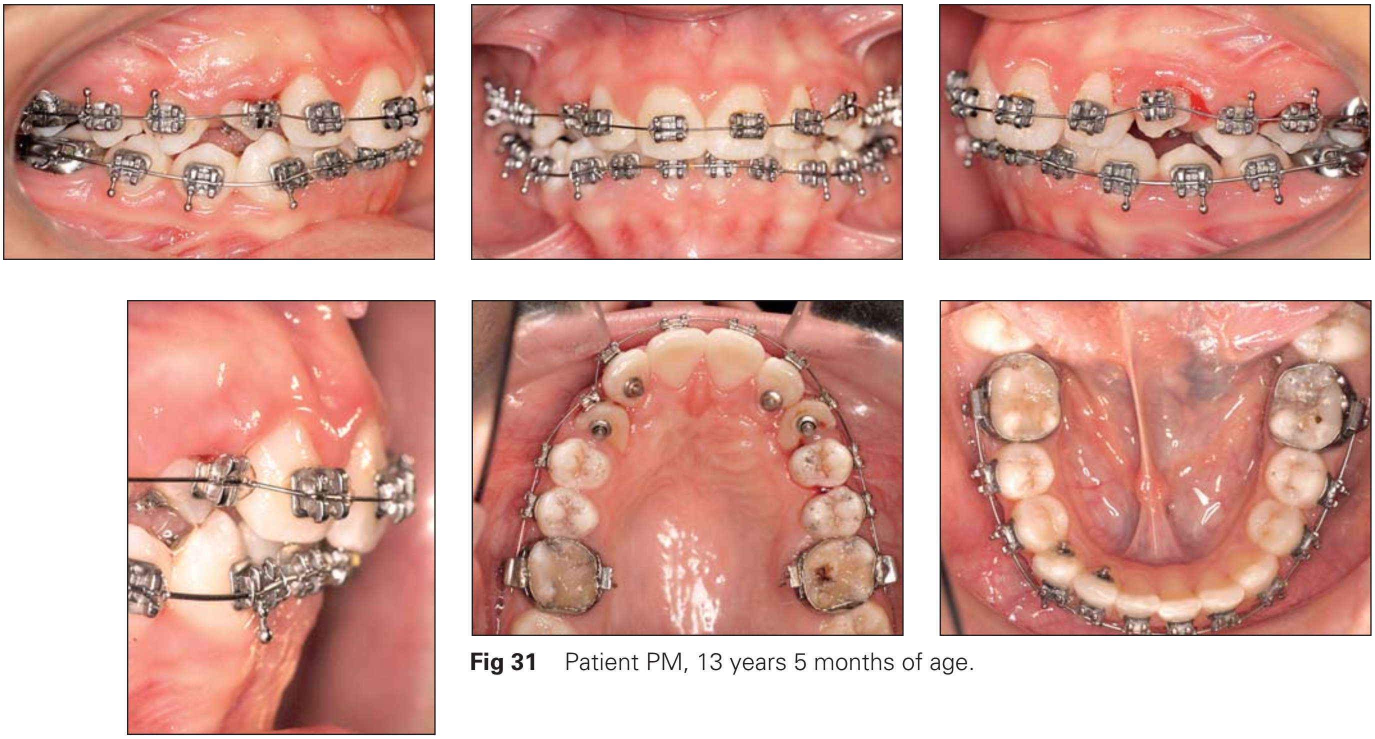


Fig 31 Patient PM, 13 years 5 months of age.

In March 2003, the right canine erupted and the authors bonded 2 buttons to obtain alignment in the arch through the use of elastic tractions. During this phase, space maintenance for the maxillary canines was obtained through passive coil springs (Fig 30). Meanwhile, the mandibular arch was banded and, in May 2003, the authors bonded the brackets on the vestibular surfaces of both maxillary canines (Fig 31).

After obtaining the coordination of the arch, the patient was debanded and the authors splinted the 6 mandibular anterior teeth (Figs 32 to 35). Later, the authors completed restorative treatment and bleaching therapies of the teeth showing enamel hypoplasia.

DISCUSSION

The main problem with the use of biomechanically active systems to extrude palatally impacted teeth concerns the rotation of the auxiliary itself. The Easy Cuspid provides a solution to this problem, as it is inserted in a double tube at the level of the dental element acting as a fulcrum (maxillary first molar). Moreover, because the auxiliary insertion is vestibular, the appliance provides excellent anchorage, both rigid and extended; rigid anchorage is provided by the main archwire that ties together the entire arch, and extended anchorage is represented by a removable palatal bar.

The bending of the helices, which are simple to manage, provides adequate elasticity to the system. The bends allow the operator to move the lever arm to the most suitable point and to guide the emerging tooth away from anatomic obstacles.

The Easy Cuspid is fabricated of stainless steel, which allows for easy welding of the active arm to the terminals. However, because of its nature, stainless steel is subject to a decline of the applied force levels. Consequently, it is necessary to reactivate the appliance every 2 to 3 weeks. These maneuvers are simple to manage and require little operator time. Nevertheless, the authors are studying prototypes built with different materials, including TMA or NiTi—not to eliminate the necessity of intermediate checks, but to keep the applied force level as constant as possible during each adjustment period.

Fig 32 Patient PM, 14 years of age. Posttreatment facial photographs.

Fig 33 Patient PM, 14 years of age. Posttreatment intraoral photographs.

Fig 34 Patient PM, 14 years of age. Posttreatment panoral radiograph.

Fig 35 Patient PM, 14 years of age. Posttreatment lateral cephalogram.

To assure the greatest patient safety, a mechanical safety tie between the Easy Cuspid and the molar band is applied to prevent any detachment of the auxiliary. Moreover, the first helix bent on the steel arm gives elasticity to the system and offers a place to pass the main arch and avoid a problem with movement of the auxiliary. This assures greater patient comfort, as well as being an ideal choice for the lever crossover since it is at the interproximal space of the antagonists.

CONCLUSIONS

Clarity and simplicity in treatment of impacted canines can be obtained during the planning stage through the use of 3-dimensional diagnostic images. They help the clinician visualize the position of the impacted tooth and its connection with adjacent anatomic structures, and better guide the impacted tooth during the therapeutic phase, eliminating or at least minimizing the possibility of iatrogenic damages.

In this article, the authors showed a case treated with the Easy Cuspid. This appliance not only allows for simple management, but is also a biomechanically correct system that minimizes reaction forces linked to the forced extrusion of palatally impacted teeth in the maxillary bone. The use of 3-dimensional CT scans allowed for better treatment planning in this case.

The benefits derived from the use of 3-dimensional data to evaluate complex problems, such as impacted canines, will lead to an increasing use of such data for routine evaluation of both dental and orthodontic cases. In addition, the use of 3-dimensional data will allow rapid-prototyping techniques in cast fabrication to prepare custom attachments for impacted teeth as well, when indicated. The availability of rapid prototyping will open new options for the orthodontist. We can only imagine that in the future it will be possible to create a true-to-life typodont, where the clinician can simulate different approaches for the correction of impacted canines.

ACKNOWLEDGMENTS

The authors are grateful to Dr Jaime De Jesus-Viñas for his helpful and valuable suggestions, but especially for his incredible support during the preparation of this manuscript.

REFERENCES

1. Caprioglio A, Ronchi L, Tettamanti L. L'utilizzo della tomografia assiale computerizzata nella diagnosi di inclusione canina. Mondo Ortodontico 2004;2:107–114.
2. Jacoby H. The “ballista spring” system for impacted teeth. Am J Orthod 1979;75:143–151.
3. Lazzati M, Macchi A, Nidoli G. Trattamento chirurgico-ortodontico della inclusione palatale completa dei canini permanenti e modifica della “Ballista spring”. Mondo Ortodontico 1983;8:35–39.
4. Kornhauser S, Abed Y, Harari D, Becker A. The resolution of palatally impacted canines using palatal-occlusal force from a buccal auxiliary. Am J Orthod Dentofacial Orthop 1996;110:528–534.
5. Crescini A. Trattamento chirurgico-ortodontico dei canini inclusi. Bologna: Ed Martina, 1998.
6. McDonald F, Yap W. The surgical exposure and application of direct traction of unerupted teeth. Am J Orthod 1986;89:331–340.
7. Darendeliler MA, Friedli JM. Case report. Treatment of an impacted canine with magnets. J Clin Orthod 1994;28:639–643.
8. Orton HS, Garvey MT, Pearson MH. Extrusion of the ectopic maxillary canine using a lower removable appliance. Am J Orthod Dentofacial Orthop 1995;107:349–359.
9. Magnusson H. Saving impacted teeth. J Clin Orthod 1990;24:246–249.
10. Terry SJ, Thomson ME. Treatment of palatally impacted cuspids with the extrusion spring arm. J Clin Orthod 1995;29:709–712.
11. Ross LL. Nickel titanium closed-coil spring for extrusion of impacted canines. J Clin Orthod 1999;33:99–100.
12. Patel S, Cacciafesta V, Bosch C. Alignment of impacted canines with cantilevers and box loops. J Clin Orthod 1999;33:82–85.
13. Fischer TJ, Ziegler F, Lundberg C. Cantilever mechanics for treatment of impacted canines. J Clin Orthod 2000;34:647–650.
14. Kalra V. The K-9 spring for alignment of impacted canines. J Clin Orthod 2000;34: 606–610.
15. Bowman SJ, Carano A. The Kilroy spring for impacted teeth. J Clin Orthod 2003;37: 683–688.
16. Oppenhuizen G. An extrusion spring for palatally impacted cuspids. J Clin Orthod 2003;37: 434–436.
17. Caprioglio A. A new device for forced eruption of palatally impacted canines. J Clin Orthod 2004; 38:342–347.