

No more monkey business with impacted canines

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Abstract

Various treatment mechanics have been created to direct the eruption of impacted teeth, including the application of intra- and interarch forces to some type of attachment on the affected teeth. The present communication describes the use of two simple auxiliaries, the Monkey Hook* and the Kilroy Spring*, for the directed eruption of impacted and/or the correction of severely rotated teeth.

Key words: Exposure of impacted teeth, impacted canines, impacted cuspids, Kilroy Spring, Monkey Hook

THE MONKEY HOOK AUXILIARY

The Monkey Hook^[1] is simply a short section of wire with open loops on opposite ends [Figure 1]. Forces to direct the eruption or rotation of teeth are applied from the Monkey Hook with intraoral elastics, elastic chains, elastic thread, or superelastic coil springs. Closing the loops with pliers permits the secure connection of the Monkey Hook to a bondable “loop button” or the linking of one hook to another to form a “chain” [Figure 2].

EXPOSURE AND ATTACHMENTS FOR IMPACTED TEETH

The advent of direct bonding has allowed for smaller exposure sites for impacted teeth with less associated morbidity when placing attachments. For instance, a loop button or bondable eyelet, consisting of a 1 mm helix of a round wire that is welded or braised to a small diameter bondable base [Figure 1], that may be easily directly bonded to nearly any exposed enamel surface of an impacted tooth. Applying an additional amount of bonding adhesive (e.g., Fuji GI LC), acting as a fillet, around (and even over

the edge of the bondable base) appears to improve the retention of this attachment.

A Monkey Hook is connected to the loop button attachment prior to the direct bonding and this combination to the exposed tooth. The vertical loop is positioned parallel to the roots of the teeth adjacent to the impacted one. In this orientation, a continuous arch wire may be placed through the lumen of this loop button later in the treatment when the directed eruption of the tooth is sufficient. If the tooth is deeply impacted, a second Monkey Hook can be easily linked to the first one. Then a stainless steel ligature is used to tie the free-end of the Monkey Hook to the bracket on a tooth adjacent to the exposure site. This will stabilize the hook until forces are later applied. As a result, a portion of the Monkey Hook may extend through gingival tissues after the exposure and is available for the application of a variety of force mechanics [Figure 3].

FORCE APPLICATIONS

For palatally impacted canines, it is important to direct the eruption of the affected tooth away from the roots of any adjacent teeth to reduce the risks of root resorption. In some instances, the tooth must be moved toward the lingual or distal before lateral movements are attempted. In addition, these teeth should first be erupted occlusally, prior to any attempt to direct the tooth laterally toward the dental arch form. As there is obviously no periodontal ligament surrounding the enamel crown of a tooth, it is nearly impossible to move the crown through bone. Consequently, eruption of the tooth vertically to clear

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the crown from the supporting bone will facilitate later lateral movements.

MONKEY HOOK FORCES

Vertical eruption

Common intraarch mechanics that have been previously used to direct the eruption of impacted teeth (e.g., elastic thread applied to a gold chain) may tend to adversely tip or intrude the adjacent teeth. As an alternative, vertical eruptive forces can be created using intermaxillary elastics, stretched from the Monkey Hook to the opposing dental arch [Figure 3]. Although there is no effect on teeth adjacent to the exposure, this arrangement introduces the unpredictable factor of patient compliance with elastic wear.

Slingshot effect

An alternative method is to produce intraarch force using multiple Monkey Hooks connected to the same loop button attachment much like keys on a key ring [Figure 3]. Elastic chains are then connected from each Monkey Hook to teeth adjacent to the exposure, thereby creating a “sling shot” effect [Figure 3]. A closed coil spring is placed on the base arch wire to prevent tipping of the adjacent teeth toward the impacted tooth. A combination of intermaxillary elastics and the “sling shot” may be used to provide simultaneous vertical and lateral eruptive forces [Figure 3].

THE KILROY SPRING AUXILIARY

The Kilroy Spring^[2,3] is a pre-formed module that is slid onto a rectangular continuous arch wire in the location of an impacted tooth [Figure 4]. The vertical loop of the Kilroy Spring extends perpendicularly to the occlusal plane in its passive state [Figure 5]. A stainless steel ligature is then threaded through the helix at the apex

of this vertical loop. Then the vertical loop is directed toward the impacted tooth. The ligature is tied either directly to the loop button or to a Monkey hook linked to that attachment. As another alternative, either the Monkey Hook or Kilroy Spring may be tied to the links of a typical “gold chain” that has been attached to the impacted tooth.

KILROY SPRING FORCES

The Kilroy Spring is supported by (1) the rectangular base arch wire, (2) reciprocal anchorage derived from the incisal one third of the adjacent teeth (where the lateral extensions or “arms” of the Kilroy Spring contact those teeth on the buccal surface) [Figure 5]. It is critical that a rectangular base wire is used to prevent adverse lingual crown torque of those adjacent teeth. The Kilroy Spring may need to be periodically re-tied or adjusted to maintain a constant force as the tooth erupts.

The Kilroy Spring was designed to produce primarily vertical and some concurrent lateral eruptive forces for palatally impacted canines [Figures 4 and 6-8]. The Kilroy II Spring produces vertical forces and was intended for buccally impacted teeth [Figure 4]. Due to the multiple helices and cantilever design of the Kilroy II, there is a chance of tissue impingement adjacent to the impacted tooth; therefore, more frequent visits to monitor progress are recommended.

The amount of force produced by either Kilroy Spring is increased or decreased by bending the vertical loop toward or away from the impacted tooth prior to its installation [Figure 9]. Due to the flexibility of this device, it can be adjusted to fit the available arch length, even if the space for the impacted tooth is wider or narrower than the impacted tooth. In addition, the vertical loop of the Kilroy Spring

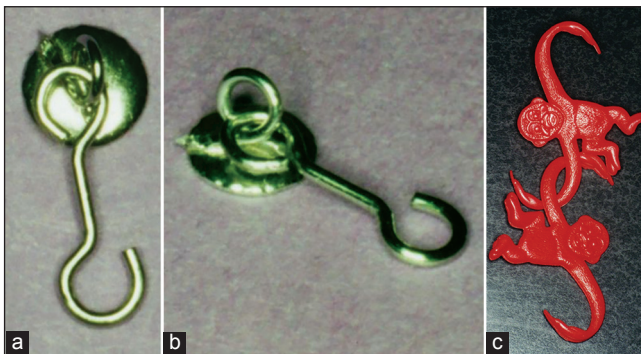


Figure 1: (a and b) The Monkey hook is a section “S-shaped” that is linked to a bondable “loop button.” This auxiliary is direct-bonded to an impacted or rotated tooth to permit the addition of directional forces via intermaxillary elastics, superelastic coil springs, or elastic chain or thread. (c) The concept was influenced by the children’s game, “Barrel Full of Monkeys”

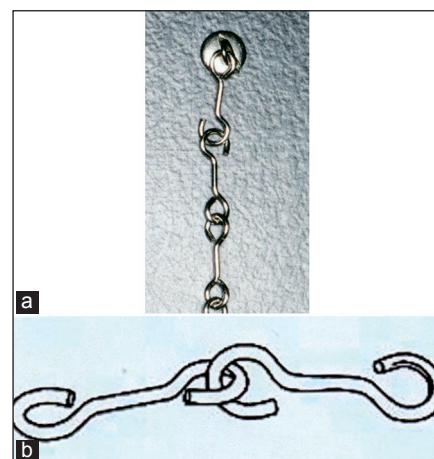


Figure 2: (a and b) Monkey hooks can be linked together to form a chain

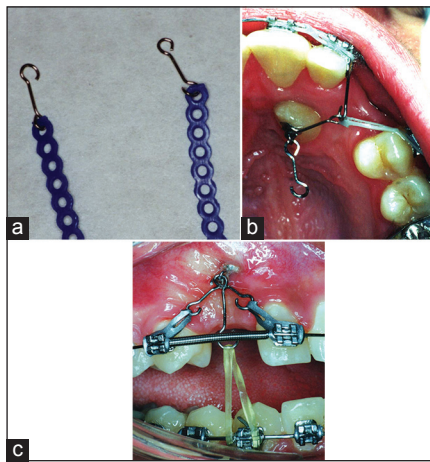


Figure 3: (a) Monkey hooks can be applied to a bonded loop button on a buccally or palatally impacted tooth. (b) Elastic chain, stretched from the Monkey hooks to brackets on the teeth adjacent to an impacted tooth, produce lateral and/or vertical directional forces (i.e., “sling shot” effect). (c) Intermaxillary elastics, supported by the opposite dental arch, can be attached to a third Monkey hook to produce vertical eruptive forces

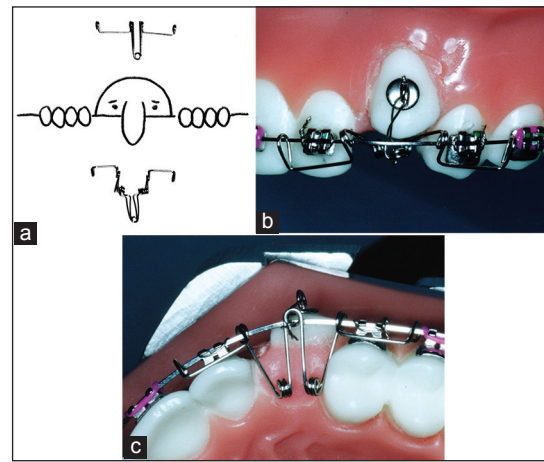


Figure 4: (a) Kilroy Springs, auxiliaries that are slid onto a rectangular continuous arch wire, were designed to produce both vertical and lateral eruptive forces for impacted teeth. The design of the Kilroy I Spring reminded (for palatal canines) the designer of the iconic “Kilroy Was Here” graffiti of the 1940s. (b and c) Kilroy II Spring was designed for use with labially impacted canines. The cantilever nature of the auxiliary requires careful adjustment to balance forces to prevent tissue impingement

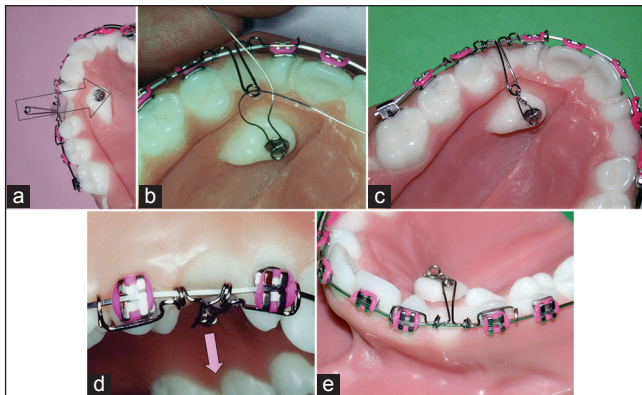


Figure 5: (a) When passive, the vertical loop of the Kilroy Spring is positioned perpendicular to the plane of occlusion. (b) To activate the Kilroy Spring, a stainless steel ligature is passed through the helix, at the end of the vertical loop, and tied to the bonded loop button on the impacted tooth. (c) The vertical loop has been directed to the impacted tooth and secured in place. (d) Vertical and lateral eruptive forces are directed to the impacted tooth by the Kilroy Spring. (e) Support is derived from (1) the continuous rectangular arch wire and (2) the incisal one third of the adjacent teeth as contacted by the extensions of the auxiliary

can be adjusted to produce some mild force to assist in closing, maintaining, or opening of that space [Figure 9].

ROTATIONAL COUPLES AND RETRACTION WITH THE MONKEY HOOK

Impacted teeth are also frequently rotated and may require directional forces to turn them into appropriate alignment. A second loop button may be bonded to the crown of the affected tooth on the side opposite that of the original attachment. Monkey Hook and elastic chain combinations are connected from each loop button in opposite directions

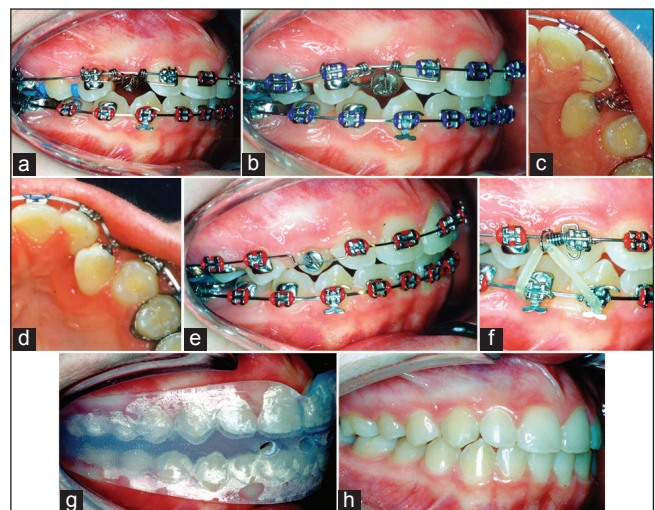


Figure 6: (a) A 13-year-old female with palatally impacted right canine. After surgical exposure and placement of a bonded loop button, a Kilroy Spring auxiliary was ligated to the affected canine as part of typical continuous arch mechanics. (b and c) After 2 months, the tooth has been mildly hyper-erupted. (d) Superelastic wire is inserted through the loop button attachment to direct the tooth labially. (e) A 0.018” stainless steel arch wire was used to “step” the canine into position. (f) Five months after surgical exposure, a bracket is bonded to the canine and a Compliance+ spring auxiliary is slid onto the round arch wire and secured in the vertical slot of the Butterfly System bracket^[4,5] and an intermaxillary elastic was used to activate the spring to produce labial root torque. (g) Immediately upon removal of the fixed appliances, a positioner was worn 24 hours/day for 1 week to finalize the occlusion and improve the gingival health.^[6,7] (h) Final result achieved in 21 months.

to produce a rotational couple (e.g., forces directed to the lingual cleft of a molar and also directed to the anterior teeth) [Figures 7 and 8]. These Monkey Hook and elastic chain or Niti coil spring combinations can also be used for

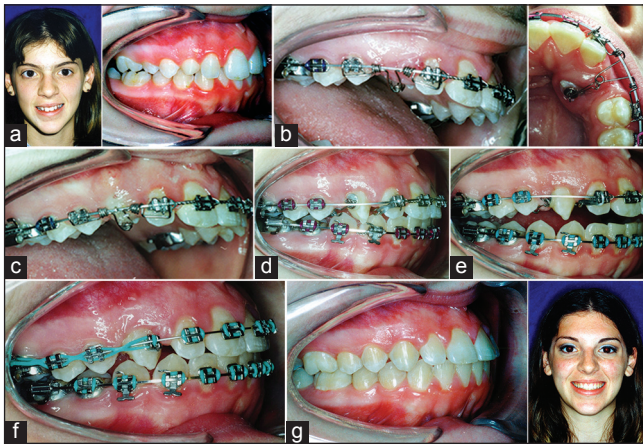


Figure 7: (a) 1,2 Twelve year old female with palatally impacted right canine. (b) 1,2 Kilroy Spring auxiliary was slid onto a rectangular arch wire and the vertical loop was ligated to the bonded attachment on the canine. Reciprocal forces to direct the eruption of the impacted tooth were derived from the adjacent teeth and the arch wire. (c) Vertical and lateral displacement after 4 months. (d) A second bonded attachment is placed on the buccal surface (distal of the canine) and 2 Monkey hooks with elastics chains are connected to the attachments to produce a rotational couple. (e) After 1 month of rotation (f) After 4 months of rotation, a bracket is bonded to the tooth. (g) Final results. Note: Kilroy Spring was in place for 8 months and rotation with the Monkey Hooks required 4 months.

sliding space closure or for retracting individual teeth and can be connected to the heads of mini-screw anchors as well [Figure 10].^[8] In these situations, the Monkey Hook is attached to a soldered, crimpable, or vertical slot hook.^[4,5] As a “low friction” alternative, a right-angle bend is made at one end of the Monkey hook and then it is “hooked over” the arch wire in the appropriate location to produce retraction [Figure 10].

SUMMARY

Initiating treatment with a bondable loop button (with a linked Monkey hook), attached during the routine surgical exposure of an impacted tooth, provides for a number of mechanical options:

1. Intermaxillary elastics may be employed from the open loop of the Monkey Hook to generate vertical eruptive forces,
2. A pre-formed Kilroy Spring auxiliary may be tied to the Monkey Hook or directly to the loop button for vertical and lateral eruptive forces without dependence upon compliance,
3. Two Monkey hooks (linked to elastic chain) may be added to produce lateral or vertical “sling shot” eruptive forces.

After sufficient eruption of the crown of the tooth, any rotations may be resolved by introducing a rotational couple using two Monkey hooks with elastic chains directing forces in opposing directions from loop buttons applied to opposite sides of the tooth. In addition, the

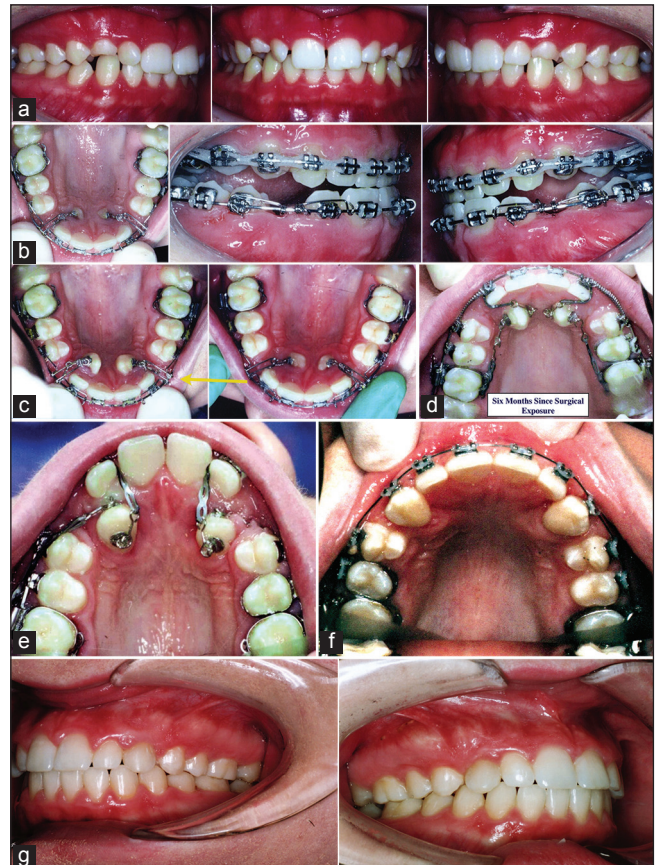


Figure 8: (a-c) A 16-year old female with palatally impacted canines that were surgically exposed and loop buttons were direct-bonded. Kilroy Springs were placed onto a rectangular arch wire and the vertical loops were tied to the bonded attachments with stainless ligatures to direct vertical eruption for 6 months. (d-f) The lingual surface of the crowns were facing labially and required a rotational couple from two Monkey Hooks and elastic chain to rotate them into correct position along with substantial labial root torque and intermaxillary elastics. (g) Treatment completed in 34 months.

base arch wire or a more flexible, auxiliary “overlay” wire may be threaded through the loop on one end of the Monkey Hook or through the lumen of the loop button to complete the directed eruption prior to the placement of a typical bracket on the tooth. The combination of the Monkey Hook, the loop button, and the Kilroy Spring offer simple and predictable solutions for the resolution of impacted and severely rotated teeth.^[9-11] Most recently, Yadav and co-workers^[12] at Indiana School of Dentistry and University of Connecticut recently reported that the Kilroy Spring “provided the most consistent force direction and minimum changes in other load components. Therefore, unnecessary jiggling of teeth can be minimized.”

Another innovative option may be to use an adaptation of the mandibular Traction Arch^[13] (a modified lingual arch) using a soldered vertical arm to direct impacted teeth into place. In this scenario, the anchorage to direct the cuspids is derived directly from the anchoring maxillary 1st molars.

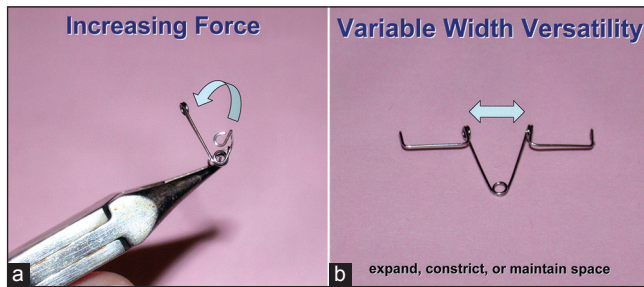


Figure 9: (a) The force produced by the Kilroy Spring can be adjusted by simply bending the vertical loop away from the impacted tooth (more force) or towards the tooth (less force). (b) The Kilroy Spring can be expanded or constricted to fit the available arch length where the impacted tooth is missing or to produce some mild forces for opening or closing that space

POSSIBLE STEPS FOR DIRECTING THE ERUPTION OF AN IMPACTED TOOTH

1. Surgical exposure.
2. Direct bonding a loop button attachment linked with a Monkey Hook.
3. Add a fillet of additional adhesive around, or even over, the bonding base of the attachment to improve retention.
4. Tie a steel ligature from the Monkey Hook to a bracket or the arch wire just stabilize it until forces are applied.
5. Vertical eruptive forces – intermaxillary elastics from the Monkey hook to the opposing arch.
6. Distal directed forces prn – Monkey Hook with elastic chain connected to a cleat or button attachment on the lingual of the first molar.
7. Vertical eruptive forces – Kilroy Spring tied to the Monkey hook or loop button.
8. Sling shot forces – Two Monkey hooks with elastic chain, linked to the loop button, directing the tooth toward the base arch wire. Coil springs on the continuous arch wire are used to open or hold space for the impacted tooth.
9. Rotational couple – loop buttons placed on opposite sides of the tooth with Monkey hooks and elastic oriented in opposite directions to “spin” the tooth.
10. Base arch wire or superelastic “overlay” auxiliary wire threaded through the loop button to center the tooth within the alveolus.
11. Bonding an orthodontic bracket to detail the correction.

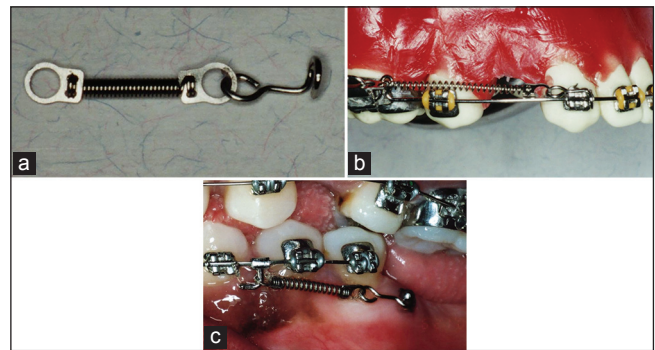


Figure 10: (a and b) Combination of Monkey Hook and superelastic coil spring used to retract individual teeth or dental segments. One end of the Monkey hook is bend 90° and is hooked over the arch wire. (c) Monkey Hooks can also be used to connect from the heads of mini-screws (TADs) to elastic chain or superelastic coil springs^[11]

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