The "ballista spring" system for impacted teeth

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Many articles have been written on the subject of impacted teeth and particularly on impacted canines. Recent works include those by Bishara and associates,[1] von der Heydt,[2] Clark,[3] and Lewis.[4] These articles treat the subject from different points of view. The physiology of eruption, the etiologic factors of the impaction, the sequelae of impaction, the diagnosis, and the different techniques are well-documented in different manners. The case reports presented by these authors prove the skill of the surgeon and the orthodontist. Very often the method proposed for the marsupialization of the impacted tooth is complicated and has to be modified several times during the treatment. The "ballista spring* system" which I developed has some advantages over the previously proposed systems. Since the upper canines are the most frequently impacted teeth with which orthodontists are concerned, my article will deal with the description of the appliance built for this purpose. The same system can be used for any impaction.

The spring

The ballista spring is a 0.014, 0.016, or 0.018 inch round wire, which accumulates its energy by being twisted on its long axis. Its anchorage extremity penetrates in both headgear and edgewise vestibular tubes of the first or second maxillary molar and it is ligated to this tube. In this way, the wire cannot rotate in the tubes (Fig. 1, *A*).

The horizontal part of the wire accumulates the energy. This part of the wire is attached by a ligature on the first premolar, which allows it to rotate in the slot of the bracket as a hinge axis. The last part of the spring is bent down vertically and ends in a loop shape to which a ligature elastomeric thread can be attached. When the vertical portion of the spring is raised toward the impacted tooth, the horizontal part accumulates the energy into the twisted metal. When the vertical section is released, it bumps down like a "ballista."

The anchorage

The spring creates a torsion on the double tube of the molar. For this reason, the molar has to be well anchored by a transpalatal 0.045 inch wire to the contralateral molar (Fig. 2). In the beginning, the first premolar was not included in the transpalatal arch because the impression was that the spring rotates only in the slot of the premolar, like a

*The name "ballista spring" was given by a patient, because its action reminded him of a Roman ballista.

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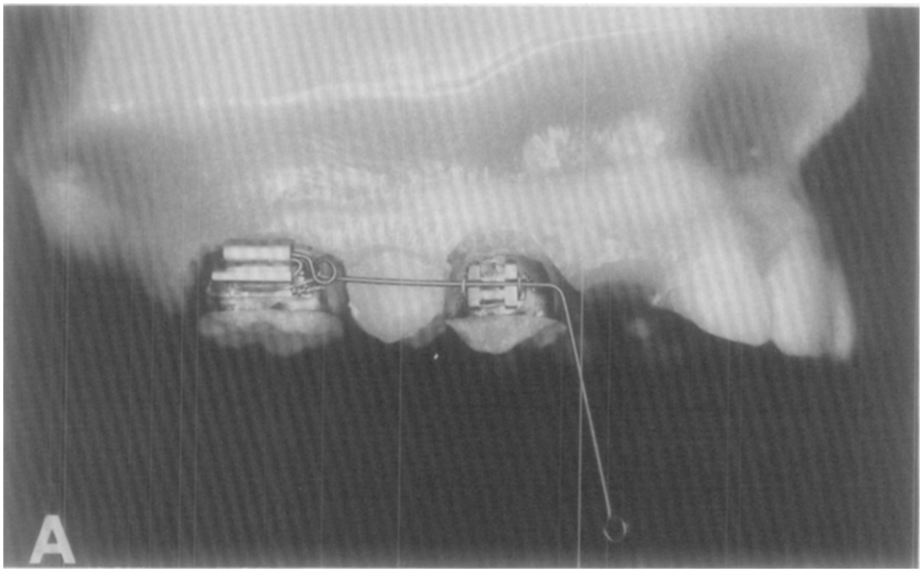

Fig. 1. The ballista spring, its anchorage and action. **A,** The ballista spring before activation. It is inserted in the molar tube and ligated in the first premolar bracket.

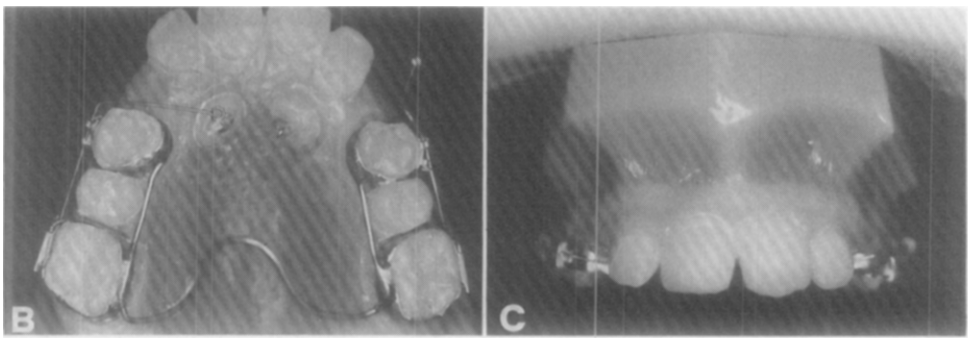

Fig. 1B and **C. B,** The anchorage for the ballista spring system. The transpalatal arch crosses the palate in the posterior region. The right spring is activated; the left one is free. **C,** By the lack of appliance on the front teeth, the esthetic side of the treatment is respected.

hinge axis. In some cases the premolar was intruded or shifted labially. Consequently, it was included in the transpalatal arch to maintain the original position (Figs. 1, *B* and 3).

Two molar bands with combination headgear and edgewise double tubes and two first premolar bands with twin or large edgewise brackets were fitted, and an impression was taken with the four bands. A lingual 0.045 inch round wire was welded to the four bands on the cast. The transpalatal wire must be posterior, between the molars, and in no case anterior (between the premolars). This avoids the wire's interference during the operation or during traction of the impacted tooth.

The four bands welded to the transpalatal arch must be cemented as a unit. This anchorage can be used in both unilaterally or bilaterally impacted canines.

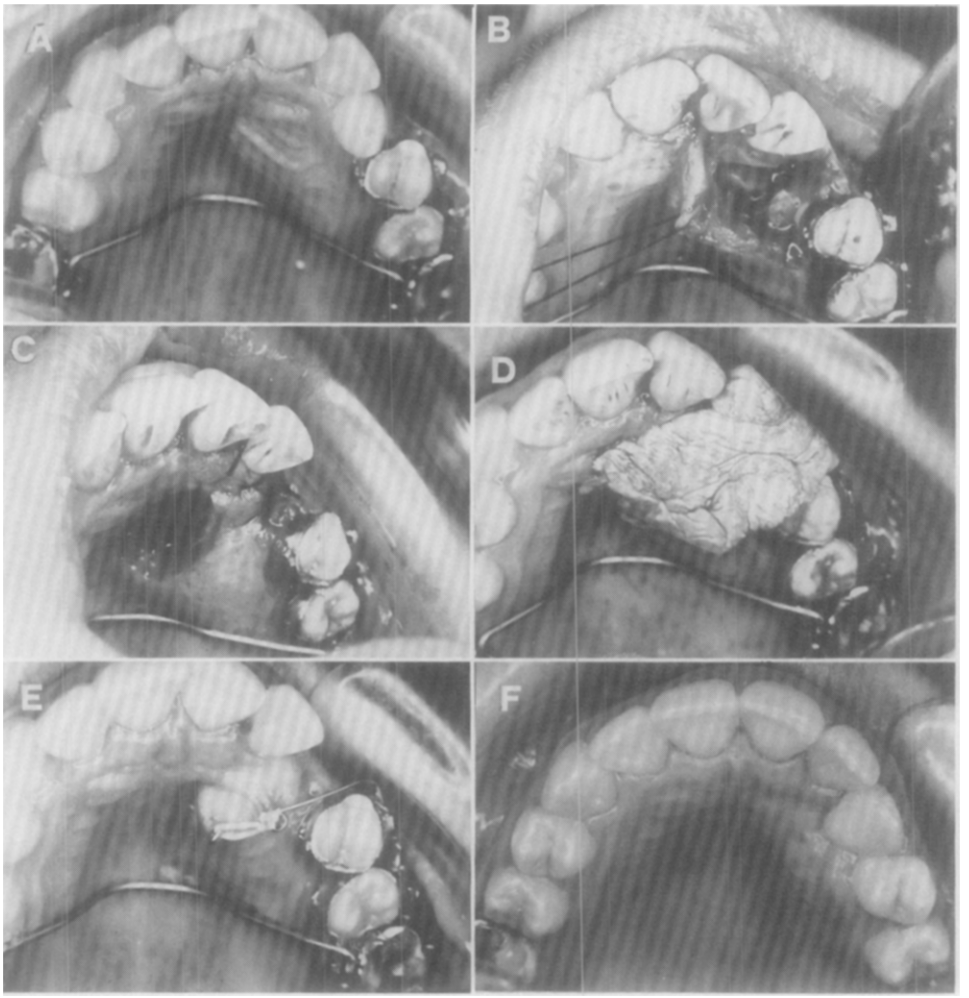

Fig. 2. Intraoral photographs of an 11-year-old girl with upper left palatally impacted canine. **A,** Anchorage before treatment; note the malposition of the incisors due to the impacted tooth. **B,** Extraction of the decidious canine and surgical liberation of the surface of the impacted tooth with a very limited flap. **C,** Fenestration and suturing of the flap. **D,** Surgical cement placed in close contact with the liberated surface of the impacted tooth. **E,** Twenty-one days after the ballista spring was inserted; note the rapid eruption of the canine. **F,** After 10 months of treatment.

Surgical preparation of the impacted tooth

A radiologic determination of the location of the impacted tooth is highly recommended. Panoramic x-ray films give good information about the degree of inclination of the impacted tooth and about the surrounding tissues. The impacted tooth can also be localized by palpating the region of the impaction. In most cases a preeminence corresponding to the impacted tooth can be palpated under the mucosa.

Anesthesia is provided by a local infiltration on the palatal and vestibular region. A

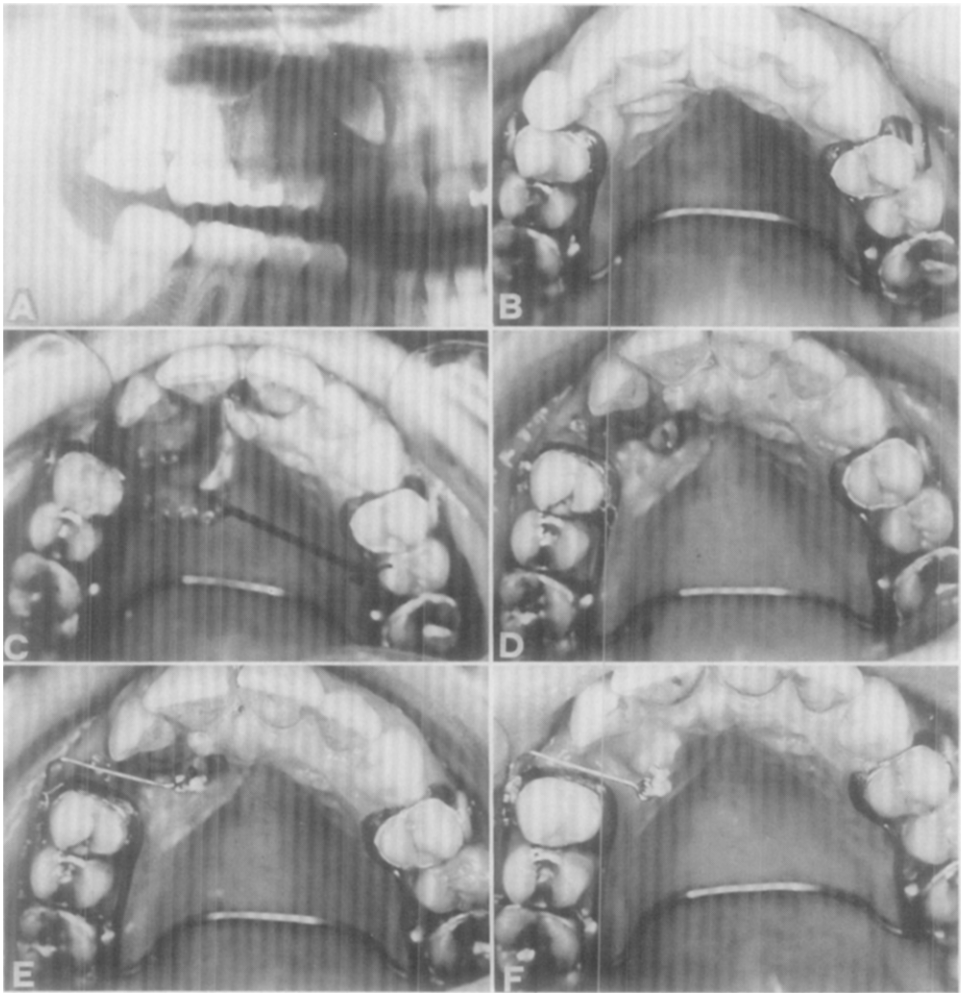

Fig. 3. Case of a 24-year-old woman with upper right impacted canine. **A,** Panoramic x-ray film. **B,** Anchorage preparation before surgery. **C,** Extraction of the decidious canine and raising of a limited surgical flap for liberation of the canine's surface. **D,** A hook is bonded on the canine's surface 10 days after the surgical intervention. **E,** The ballista spring inserted and activated the same day. **F,** 10 weeks of ballista spring action; note the considerable eruption of the canine.

small limited flap is raised over the impacted tooth (Figs. 2 and 3). The superficial enamel of the impacted tooth is completely liberated from bone, enamel organ, and cuticula. No osteotomy in the proximal parts or around the tooth is required. A fenestration in the mucosal flap overlapping the exposed tooth is incised, and the rest of the flap is sutured.

Special attention should be given to the article by Vanarsdall and Corn,[5] in which the authors emphasize the importance of the attached gingiva that remains after the retraction of labially impacted teeth. When dealing with unerupted teeth, the surgeon must carefully plan his flap and bring attached fibrous mucosa in contact with the operated tooth. In general, the palatally impacted tooth is surrounded by attached mucosa. On the contrary,

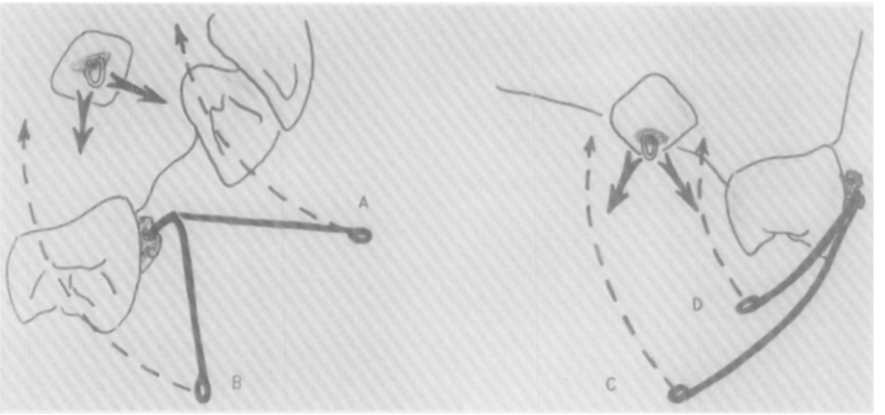

Fig. 4. Possible modifications of the ballista spring. When the spring is inclined forward **(A)** or backward **(B)**, it adds a forward or a backward traction to the vertical component. When the spring is lengthened **(C)** or shortened **(D)**, it adds a median or a lateral traction.

the vestibular impacted tooth, or the lower lingually impacted tooth may be drawn through the loose gingival mucosa, and the final result could be a good orthodontic alignment with a poor periodontal mucosal attachment.

After the operation, a surgical cement is pushed into the fenestration in order to contact the exposed area of the tooth. This cement is inserted laterally in the retentive parts of the premolar's vestibular bracket and around the palatal 0.045 inch wire (Fig. 2). No surgical acrylic plates are necessary.

This surgical procedure is called marsupialization, because the surgical cement avoids the covering of the tooth by the healing mucosa; the enamel organ fuses with the palatal mucosa of the fenestration, around the surgical cement.

Ten days after the operation, the surgical cement and the sutures are removed, and a small 0.012 inch round wire hook is bonded to the exposed enamel surface of the canine through the fenestration. In order to apply the bonding material to the impacted tooth against the gravitation force, one has to choose a bonding composite which is applied with a thin brush.* The ballista spring described above is inserted in the molar tubes, ligated to the molar and premolar, and the vertical part is carefully raised and ligated to the bonded hook on the canine by an elastomeric thread.

Force of the spring

The force of the spring is proportional to the diameter of the wire and to the length of the horizontal and vertical parts of the spring. A 0.016 inch spring of average size provides a force of 60 to 100 grams; a 0.018 inch spring of average size provides a force of 120 to 150 grams. For a normal case, it is advisable to start with a 0.016 inch wire and to change it to a 0.018 inch after a month. If, after 2 months of treatment, no progress is registered because of severely impacted canines or tissue resistance, one can add a second spring in the same tube to increase the force operating on the impacted tooth.

Attention must be given to young patients with partially formed roots of the impacted

*Orthomite II (Rocky Mountain) or Bond-Eze (Unitek).

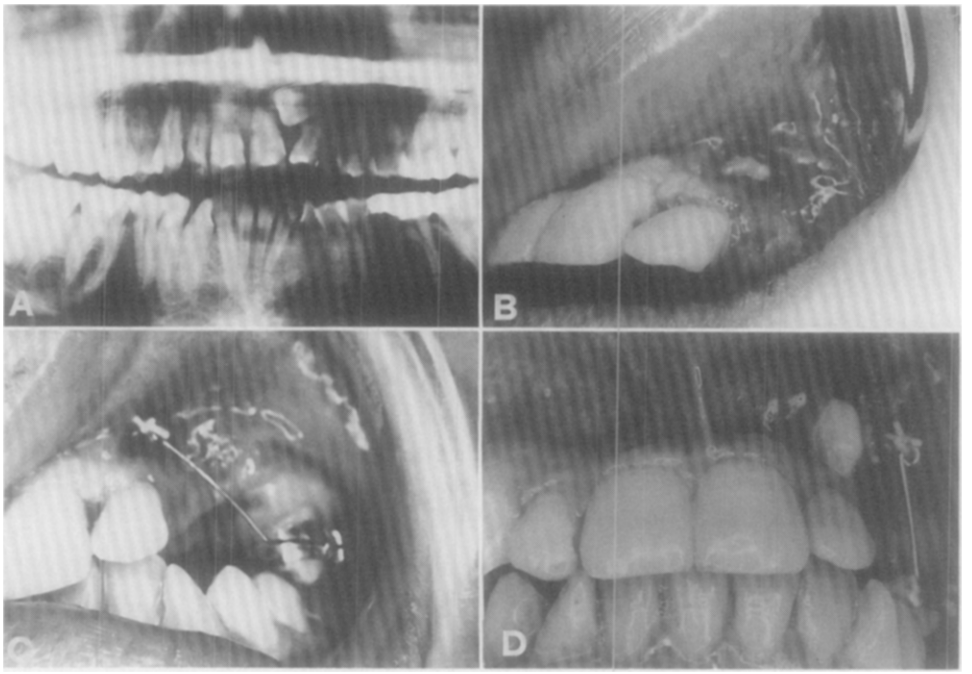

Fig. 5. Case of a 19-year-old male patient with upper left vestibular impacted canine. **A,** Panoramic x-ray film. **B,** Impacted tooth 10 days after the operation; note that no vertical traction is possible before moving the tooth laterally or distally. **C,** Engagement of the spring with a lateral force. **D,** Result, after 4 months of traction.

tooth, especially when the tooth is straight, without axial inclination. In such a case, the tooth can be induced to erupt in 2 to 3 weeks by this system. Such a rapid eruption is not desirable since the tooth may become loose. In such a case, the treatment has to be started with a 0.014 inch wire, and should be checked every week. If a tooth becomes loose, the spring should be removed and the tooth splinted until consolidation, before a new activation is possible.

Advantages of the ballista spring system

The importance of the system is in the new perspective of treating impacted teeth and in the advantages of this system over the other systems.

1. Most impacted teeth are in close proximity to the roots of the adjacent teeth. A simple straight traction between the impacted tooth and the edgewise vestibular arch wire means the compression of the impacted tooth against the roots of the adjacent teeth with failure in the treatment. The attachment of an impacted tooth to a lingual arch by an elastic is inefficient because the distance is not sufficient to activate the elastic properly without disturbing the movement of the tongue.

The ballista spring system uses a spring which creates a vertical traction on the impacted tooth toward the middle of the palate. By this, it separates the impacted tooth from the roots of the adjacent teeth. By modifying the vertical part of the spring, one can control the direction of the eruption of the impacted tooth. If the spring is inclined forward

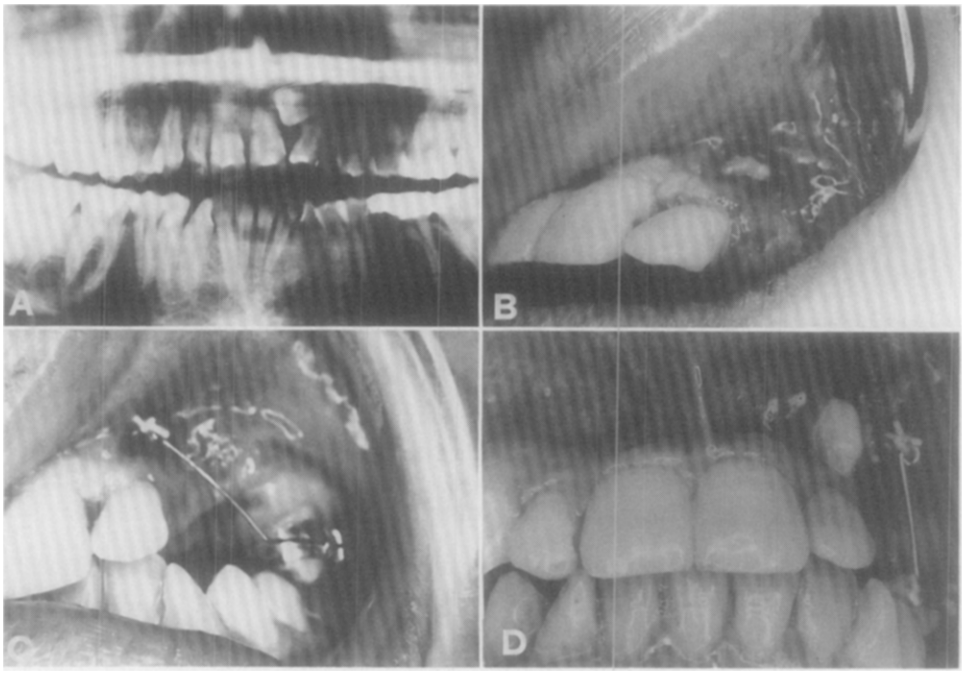

Fig. 6. Case of an 11-year-old boy with upper right vestibular impacted canine, causing the rotation of the central and lateral incisors. **A,** Before treatment. **B,** Panoramic x-ray film. **C,** Vestibular traction exerted by the spring. **D,** After 10 months of treatment.

or backward, it adds these components to the vertical traction (Fig. 4). By lengthening the vertical part of the spring, it adds a force toward the midline of the palate, and by shortening it adds force toward the dental arch.

Once the ballista spring is attached to the hook, it becomes tangent to the oral mucosa and it does not disturb the patient (Fig. 1, *C*).

2. The ballista spring is easily inserted and ligated, and it is independent from the other parts of the appliance. The spring provides a continuous force that is well controlled and easily modified. Usually, by changing two to three springs, one can obtain the complete marsupialization of the canine's crown in the oral cavity.

3. In general, treatments of impacted teeth are lengthy. Most systems require full banding at the beginning of the treatment with potential esthetic problems in adults. This system does not require any banding of the front teeth during the active marsupialization stage. At a later stage, when the crown erupts completely, the anterior teeth and the canines are bonded or banded. This second stage involves the normal placement of the canine in the dental arch with proper torque.

4. The surgical procedure for the impacted tooth in this system is less traumatic in comparison to some other systems. The flap is very limited and can heal rapidly. There is minimal trauma to the impacted tooth or to the adjacent teeth during the operation. Large flaps osteotomy around the crown of the impacted tooth close to the adjacent roots, circumferential wires around the crown, perforation in the crown in order to pass ligature

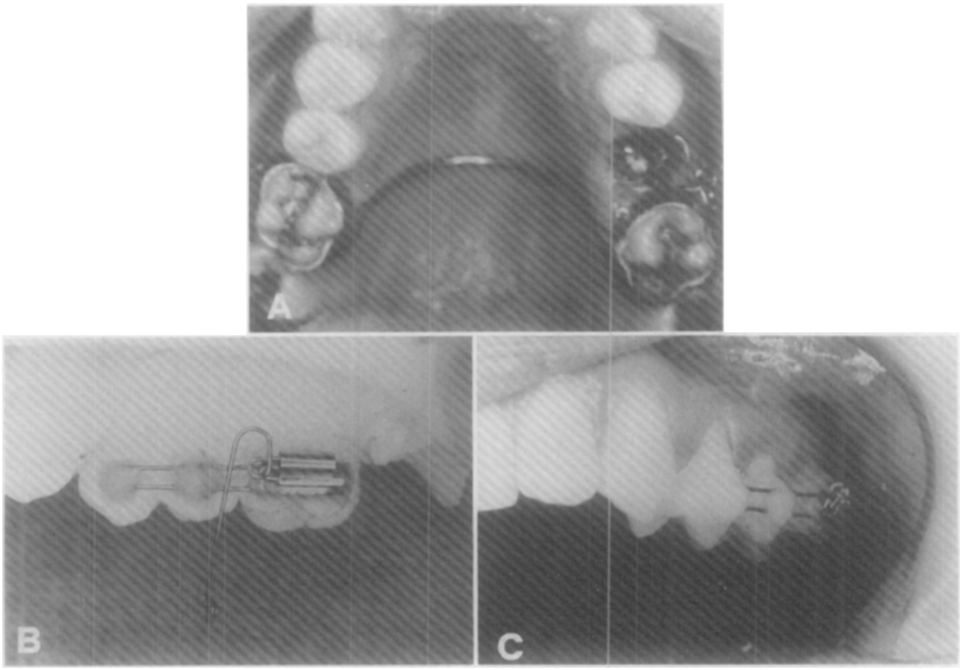

Fig. 7. A, Short ballista spring for marsupialization of the upper left second premolar in a 19-year-old patient. **B,** Indirect preparation of anchorage and spring for marsupialization of the upper left second molar in a 26-year-old woman. **C,** The same appliance in place, with activated spring.

wires, and drilling of holes to attach screws, golden chains, or other similar devices can be avoided.

5. The palatal impaction of the canine is the most frequent problem and was chosen for the description of the system. The ballista spring can also be used to retract impacted upper incisors, impacted upper and lower vestibular canines (Figs. 5 and 6), impacted premolars (Fig. 7, *A*), and impacted molars (Fig. 7, *B* and *C*). In all these cases, the principle is the same, with small modifications of the anchorage or the spring. Only the degree of imagination of the practitioner is a limit to the system. This system permits treatment in young patients or in adults of badly impacted teeth which previously were considered nontreatable.

Discussion

I found that 32.5 percent of my orthodontic patients have some canine problems. Many young patients, under the age of 12, have mesially inclined buds of the upper canines, as seen in panoramic x-ray films. Some young adolescents show ectopic eruption or space problems for the upper canines. Approximately 7 percent of my cases under treatment involve impacted teeth. That percentage is probably high in my practice, because of my interest in this problem.

The frequency of impaction for the upper canines is fifty times greater than for the lower. The comparative frequency of palatal to vestibular impaction is 12 to 1, respectively. On the other hand, the vestibular ectopic eruption (without impaction), is much

more frequent than the palatal ectopic eruption. This means that the upper canine rarely remains impacted if it is located in a vestibular position. The rate of impacted canines between the sexes is 2 males for 5 females. Johnson[6] found a rate of 1 to 3 between males and females.

Having more than 4 years of experience with the ballista spring system, I have performed forty marsupializations of impacted teeth in patients between 11 and 30 years of age. In general, the duration of the treatment is between 6 and 10 months. This equals the time necessary for the physiologic eruption of the canine. In two young patients, 12 and 13 years old, the marsupialization was accomplished in 2 months. In three other cases, the marsupialization was longer than 1 year. In adults patients, without the potential eruption of the canine, the duration of the treatment is not a factor of age, but of the degree of the impaction, of the resistance of the boney tissue, and especially of the resistance of the palatal fibromucosa. The longest treatment usually is in cases with bilateral highly horizontal palatally impacted canines which are generally considered as "lost impacted teeth" by many surgons and orthodontists.

The limited surgical procedure, the control of the orthodontic forces, the simplicity of the appliance, the comfort of the patient, and the lack of esthetic problems from anterior appliances during the great part of the treatment give this system great advantages over most other systems used in the management of impacted teeth.

Summary

The ballista spring system is a simplified orthodontic system for treating impacted teeth. The impacted tooth is retracted by a spring that accumulates a continuous force from being twisted on its long axis.

The necessary operation on the impacted tooth is simple and less traumatic. The force exerted on the tooth is vertical, without compressing the impacted tooth toward the adjacent roots. This force is well controlled and easily modified. By the lack of appliance on the front teeth during a great part of the treatment, the esthetic side of the treatment is respected. Complicated impacted teeth in adults can be treated.

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