

# Alveolar bone development after decoronation of ankylosed teeth

BARBRO MALMGREN, OLLE MALMGREN & JENS OVE ANDREASEN

Decoronation of ankylosed teeth in infraposition was introduced in 1984 by Malmgren and co-workers (1). This method is used all over the world today. It has been clinically shown that the procedure preserves the alveolar width and rebuilds lost vertical bone of the alveolar ridge in growing individuals. The biological explanation is that the decoronated root serves as a matrix for new bone development during resorption of the root and that the lost vertical alveolar bone is rebuilt during eruption of adjacent teeth. First a new periosteum is formed over the decoronated root, allowing vertical alveolar growth. Then the interdental fibers that have been severed by the decoronation procedure are reorganized between adjacent teeth. The continued eruption of these teeth mediates marginal bone apposition via the dental-periosteal fiber complex. The erupting teeth are linked with the periosteum covering the top of the alveolar socket and indirectly via the alveolar gingival fibers, which are inserted in the alveolar crest and in the lamina propria of the interdental papilla. Both structures can generate a traction force resulting in bone apposition on top of the alveolar crest. This theoretical biological explanation is based on known anatomical features, known eruption processes and clinical observations.

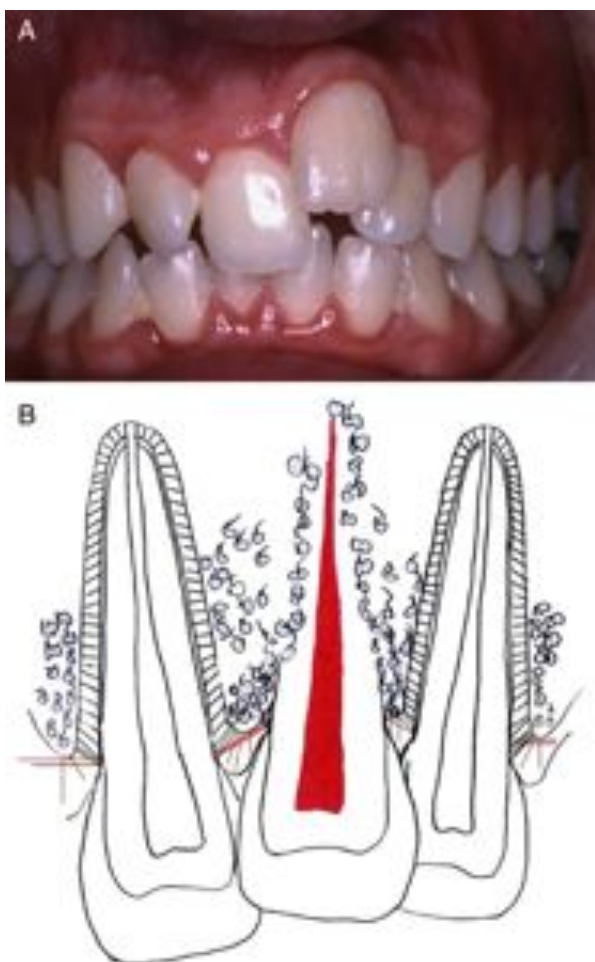
## Introduction

Dentoalveolar ankylosis is a frequent complication after replantation. This complication is accompanied by an increasing infraocclusion of the affected tooth in children and adolescents (2), and to a lesser degree also in adults (3). Most avulsions occur during the ages of 8–12 years when growth of the jaws and alveolar processes is intense. The growth varies individually above all with the general skeletal growth, age and gender. The growth directions of the jaws are also important factors (2). The retarded growth of the bone around the ankylosed tooth is frequently accompanied by tilting of adjacent teeth (Fig. 1). This tilting is caused by the interdental fibers between the submerging ankylosed tooth and neighboring teeth (4, 5).

Extraction of an ankylosed tooth usually leads to loss of attached bone; the thin buccal plate of the maxilla and socket healing become particularly jeopardized, i.e. with a defect both in the horizontal and vertical dimensions (Figs 2 and 3). In 1984, Malmgren and co-workers (1) developed the concept of *decoronation*

with the idea that by maintaining the resorbing root, the labial contours of the socket could be preserved, allowing more optimal conditions for a later implant insertion. In a study of 77 replanted and subsequently decoronated teeth, it was found that vertical growth of the socket also took place in patients with residual vertical alveolar growth (6–8).

Remodelling and growth of alveolar bone in children and adolescents is intimately connected to skeletal jaw growth and tooth eruption. The collagen fiber system with free gingival, circular, transeptal and periodontal fibers formed during eruption of teeth plays an important role for this development (9, 10). Alveolar growth is diminished if the fiber system around the teeth is lacking as in cases of missing teeth (11). The marginal fiber anatomy in the interdental area is therefore of fundamental importance for alveolar bone development if ankylosis and infraocclusion occur after trauma. They are also of importance for explanations of the favorable bone development after decoronation of such teeth. The purpose of this paper is to propose how known anatomical structures and physiological events



**Fig. 1.** Ankylosis following replantation in a 17-year-old boy. **A.** Maxillary left central incisor is ankylosed in an infra-occluded position 4 years after avulsion and replantation. Note the tilting of the adjacent teeth. **B.** Graphic illustration showing gradual bony replacement of the root, preventing it from erupting normally. The interdental ligament fibers tilt the adjacent teeth towards the ankylosed tooth.

can explain both the horizontal stability of the alveolar process and the vertical growth of the marginal alveolar bone after decoronation in children and adolescents with active jaw growth.

### Anatomy (Fig. 4)

It has been shown in histological studies that the collagen fiber system is very complex. The free *alveolo-gingival fibers* insert in the marginal alveolar crest and the interdental septum and radiate coronary into the gingival lamina propria (9). The interdental, *transeptal fibers* originate from the cervical root cementum of one

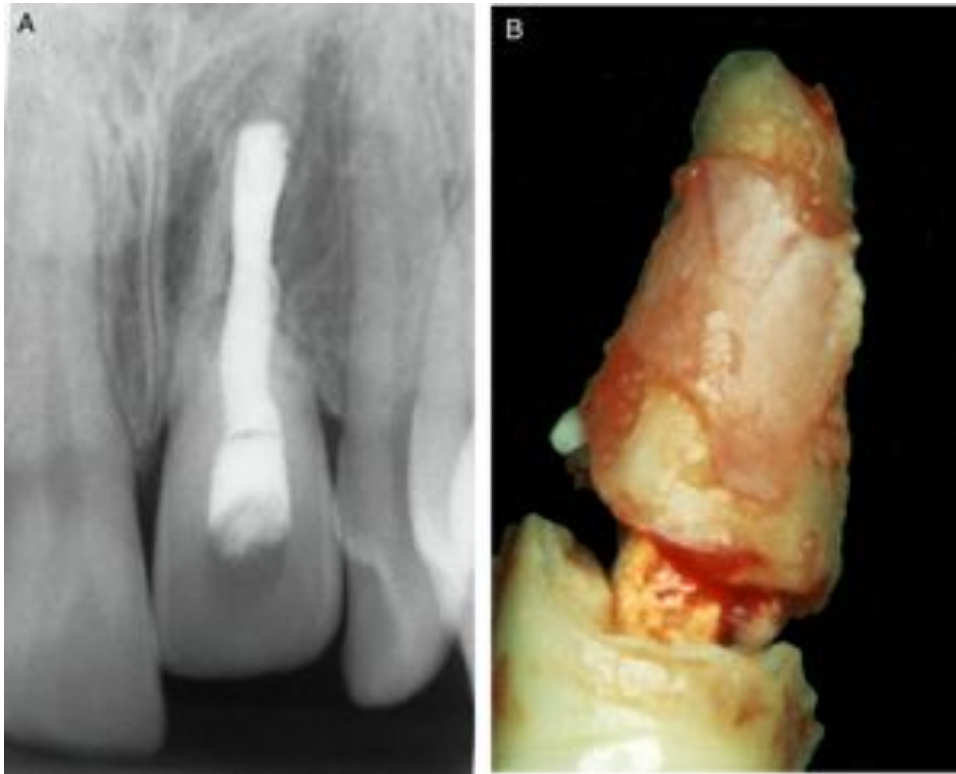
tooth and transverse horizontally through the attached portion of the interdental gingiva and insert into the cervical cementum of the adjacent tooth (12). The interdental fibers create a force between teeth and are responsible for the mesial drift of teeth to compensate for constant proximal wear. The phenomenon was proven in classical experiments by resecting these fibers (13–19). Another factor of interest is that the interdental fibers are re-established after extraction of a tooth, resulting in tipping of the adjacent teeth (20) (see Fig. 1). The *periodontal fibers* that insert on top of the interdental bone ensure that the marginal bone level is constantly adjusted during tooth eruption, probably due to traction from the fibers (11, 21). When two adjacent teeth are erupting, bone apposition occurs on top of the interdental septum via forces from both the periodontal and gingival fibers. In this way, the forces from these marginal fibers form an active alveolar periosteum in growing individuals (21).

### Ankylosis

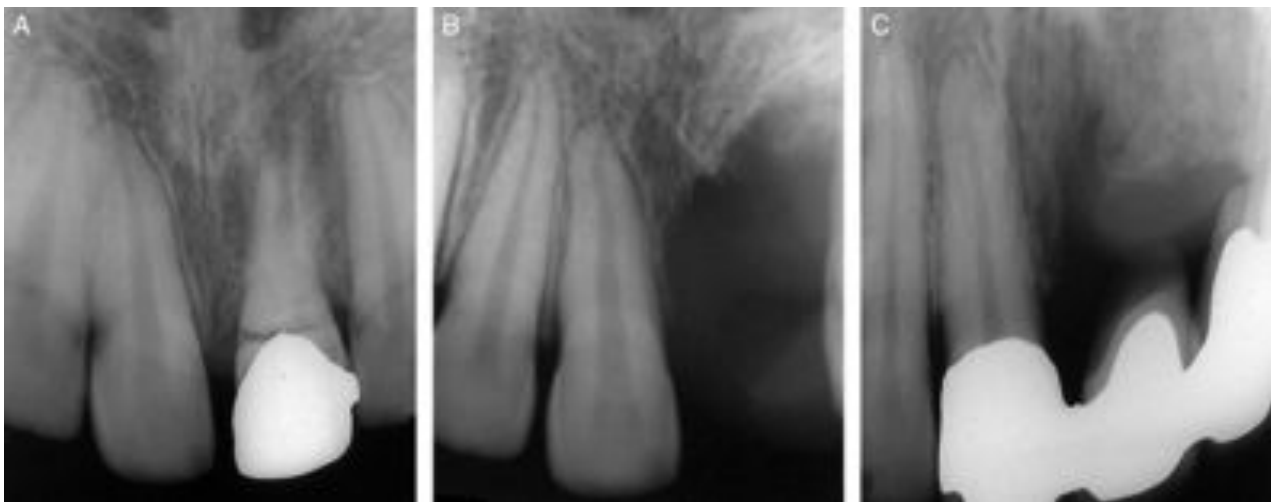
Several fibers are involved when a tooth becomes ankylosed and infraoccluded in a patient with growing jaws. The periodontal fibers are partially or totally replaced by bone in the ankylosed area and the tooth eruption is completely arrested. No marginal bone development can be seen. The interdental fibers still link the ankylosed tooth to neighboring teeth and thus partially prevent their eruption. However, the linked fibers cause tipping of the teeth as they continue to erupt.

### Decoronation (Figures 5 and 6)

Decoronation, the removal of the crown just below the cervical bone margin, was introduced to prevent severe bone loss from extraction of ankylosed teeth. It appears that a thin layer of bone apposition takes place over the resorbing root, probably from the action of interdental fibers between adjacent teeth and dentoperiosteal fibers linked to adjacent teeth having formed a new periosteum on top of the alveolar crest. The ongoing eruption of the teeth induces bone apposition through traction from the fibers on the periosteum. This explanation is in accordance with known bone-inducing effects during normal dental eruption (10). Similar findings have been observed after



**Fig. 2.** An ankylosed tooth to be extracted. **A.** Radiograph of ankylosed tooth in infraposition taken before surgery. **B.** Extracted tooth with some attached bone leaving the alveolus with little support.



**Fig. 3.** **A.** Radiograph of an ankylosed tooth in infraposition which, for esthetic reasons, has a prosthetic crown on the tooth. Following a cervical fracture, the tooth was extracted. **B.** Radiograph taken 1 month after surgery. **C.** Radiograph taken 11 years later. In the meantime, the lateral incisor also had to be extracted due to associated bone loss.

auto-transplantation of teeth. Marginal alveolar bone deposition has been observed when transplanted teeth were put into an infra-occluded position and afterwards erupted into a normal position (11).

Decoronation of ankylosed teeth can also be indicated after active growth of the jaws and eruption of the adjacent teeth is minimal. Such a situation may occur during orthodontic treatment or while

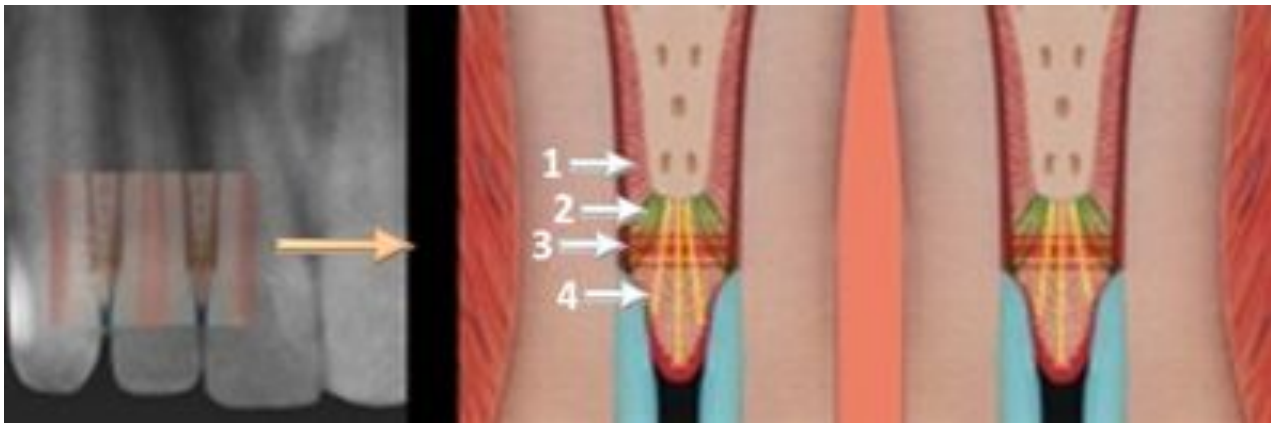
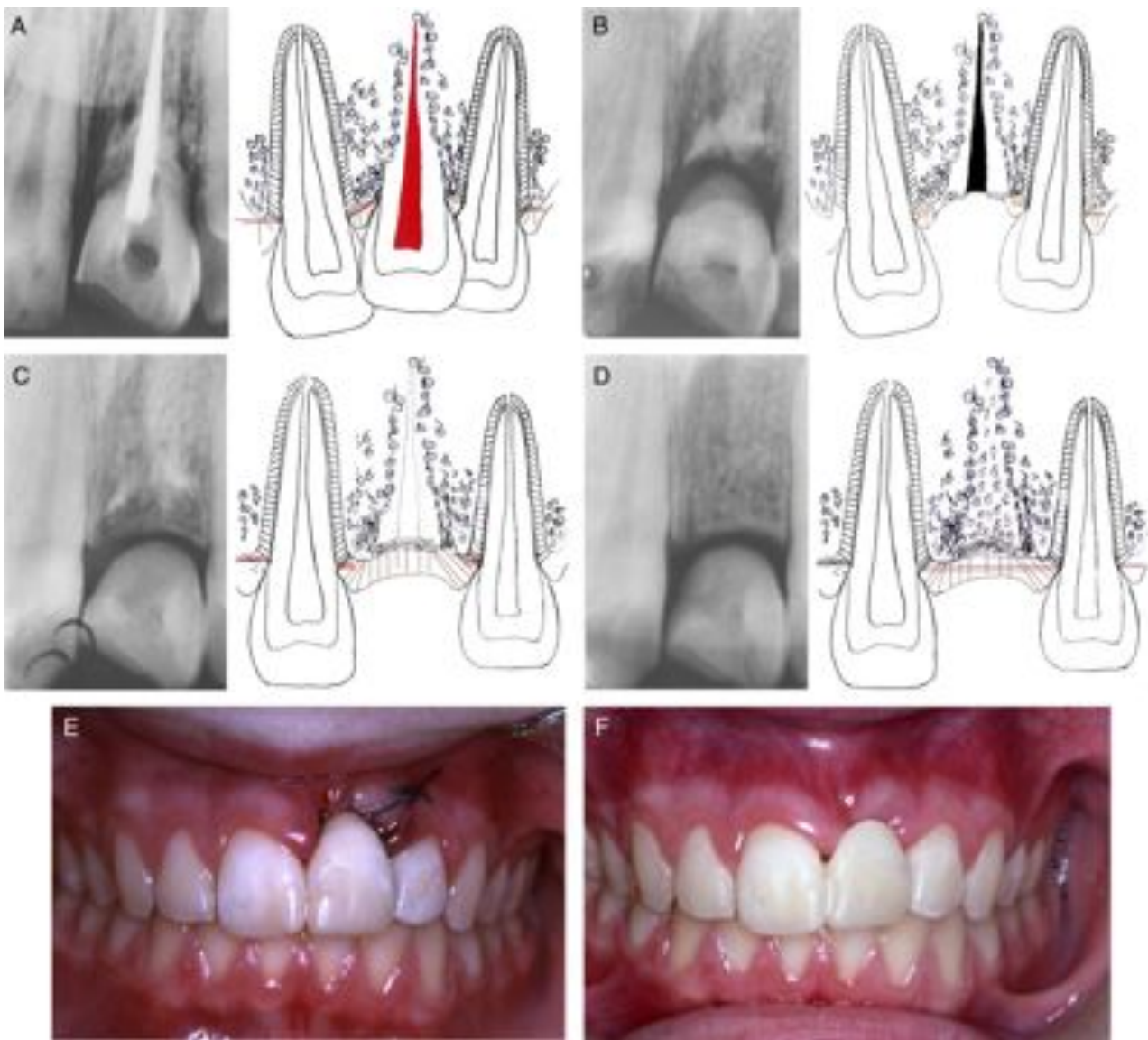


Fig. 4. Graphic illustration of a root-filled replanted incisor with optimal periodontal healing. 1. Sharpey's fibers (black). 2. Dental periosteal fibers (green). 3. Interdental fibers (red). 4. Alveolo-gingival fibers (yellow).



Fig. 5. Decoronation of an ankylosed, infrapositioned incisor. A. The right maxillary incisor in moderate infraposition has been filled with calcium hydroxide in a 14-year-old boy. B. A mucoperiosteal flap has been raised and the crown has been removed. The coronal part of the root is reduced to a level about 1.5–2.0 mm below the alveolar crest. The calcium hydroxide is removed from the canal, which is instrumented to induce bleeding into the canal. C. Radiograph taken immediately after the surgery. D–H. Ten years after the decoronation procedure, an implant is placed in an optimal position because of the ideal healing of the alveolar ridge. From Malmgren & Malmgren (8).



**Fig. 6.** Decoronation of an ankylosed maxillary central incisor in a 13-year-old boy. A-B. Radiographs and graphic illustrations pre-operative and immediately after the decoronation. Note the bone level after decoronation. Arrows indicate the cementum-enamel junctions of adjacent teeth. C. Radiograph and illustration 6 months after surgery. Note that the pontic had to be shortened due to formation of marginal bone coronal to the root remnants. D. Radiograph and illustration 12 months after surgery. No root remnants can be seen, and because of the continuous vertical shift of the marginal bone, the pontic had to be shortened again. E. Clinical appearance at the time of decoronation. F. Clinical picture illustrating the need for the shortening of the pontic due to addition of marginal bone.

waiting for the optimal time for implant placement. The remaining resorbing root substance then serves as a matrix for bone formation and prevents reduction of the labiolingual dimension of the alveolar ridge. Even an uncomplicated extraction will reduce the alveolar bone volume. This reduction has been estimated to be 18–25% of the bone mass (22–24) and might jeopardize future implant therapy. It is

also important to keep in mind that tooth eruption continues even after active growth of the jaws (usually 1/10 of a millimeter per year) (3, 25). It has been clinically observed that when the area over a decoronated root is exposed several years later in connection with implant surgery, small remnants of the root can be recognized but the labial eminence is preserved.

## Conclusion

The clinical finding that decoronation can maintain or re-establish normal alveolar conditions is very important for successful implant insertion later. The predictable success of decoronation also strongly supports the indication for replantation of avulsed teeth in children even when the extra-alveolar conditions indicate that healing might be compromised by ankylosis.

## References

- Malmgren B, Cvek M, Lundberg M, Frykholm A. Surgical treatment of ankylosed and infrapositioned reimplanted incisors in adolescents. *Scand J Dent Res* 1984; **92**: 391–399.
- Malmgren B, Malmgren O. Rate of infraposition of reimplanted ankylosed incisors related to age and growth in children and adolescents. *Dent Traumatol* 2002; **18**: 28–36.
- Kawanami M, Andreasen JO, Borum MK, Schou S, Hjorting-Hansen E, Kato H. Infraposition of ankylosed permanent maxillary incisors after replantation related to age and sex. *Endod Dent Traumatol* 1999; **15**: 50–56.
- Becker A, Karnei-R'em RM. The effects of infraocclusion: part 1. Tilting of the adjacent teeth and local space loss. *Am J Orthod Dentofacial Orthop* 1992; **102**: 256–264.
- Becker A, Karnei-R'em RM. The effects of infraocclusion: part 2. The type of movement of the adjacent teeth and their vertical development. *Am J Orthod Dentofacial Orthop* 1992; **102**: 302–309.
- Malmgren B. Decoronation: how, why, and when? *J Cal Dent Assoc* 2000; **28**: 846–854.
- Andreasen JO, Malmgren B, Bakland L. Tooth avulsion in children: to replant or not. *Endod Topics* 2006; **14**: 28–34.
- Malmgren O, Malmgren B. Orthodontic management of the traumatized dentition. In: Andreasen JO, Andreasen FM, Andersson L, eds. *Textbook and Color Atlas of Traumatic Injuries to the Teeth*, 4th edn. Oxford: Blackwell, 2007: 669–715.
- Marks SC Jr, Schroeder HE. Tooth eruption: theories and facts. *Anat Rec* 1996; **245**: 374–393.
- Andreasen JO. Normal and abnormal tooth eruption in humans. In: Andreasen JO, Kolsen Petersen J, Laskin DM, eds. *Textbook and Color Atlas of Tooth Impactions*. Copenhagen: Munksgaard, 1996: 49–64.
- Andreasen JO, Andersson L, Tsukiboshi M. Autotransplantation of teeth to the anterior region. In: Andreasen JO, Andreasen FM, Andersson L, eds. *Textbook and Color Atlas of Traumatic Injuries to the Teeth*, 4th edn. Oxford: Blackwell, 2007: 740–760.
- Schroeder HE. *Handbook of Microscopic Anatomy. Vol. V/5. The Periodontium*. Berlin, Heidelberg: Springer-Verlag, 1986: 246–247.
- Gould MS, Picton DC. A study of pressures exerted by the lips and cheeks on the teeth of subjects with normal occlusion. *Arch Oral Biol* 1964; **32**: 469–478.
- Lear CS, Catz J, Grossman RC, Flanagan JB, Moorrees CF. Measurement of lateral muscle forces on the dental arches. *Arch Oral Biol* 1965; **10**: 669–690.
- Moss JP, Picton DC. Experimental mesial drift in adult monkeys (*Macaca irus*). *Arch Oral Biol* 1967; **12**: 1313–1320.
- Moss JP, Picton DC. Mesial drift of teeth in adult monkeys (*Macaca irus*) when forces from the cheeks and tongue had been eliminated. *Arch Oral Biol* 1970; **15**: 979–986.
- Moss JP, Picton DC. The effect on approximal drift of cheek teeth of dividing mandibular molars of adult monkeys (*Macaca irus*). *Arch Oral Biol* 1974; **19**: 1211–1214.
- Moss JP, Picton DC. Short-term changes in the mesiodistal position of teeth following removal of approximal contacts in the monkey *Macaca fascicularis*. *Arch Oral Biol* 1982; **27**: 273–278.
- Moss JP. A review of the theories of approximal migration of teeth. In: Poole DFG, Stack MV, eds. *The Eruption and Occlusion of Teeth*. London: Butterworths, 1976: 205–212.
- Murphy WH Jr. Oxytetracycline microfluorescent comparison of orthodontic retraction into recent and healed extraction sites. *Amer J Orthodont* 1970; **58**: 215–239.
- Andreasen JO, Løvschall H. Response of oral tissues to trauma. In: Andreasen JO, Andreasen FM, Andersson L, eds. *Textbook and Color Atlas of Traumatic Injuries to the Teeth*, 4th Edn. Oxford: Blackwell, 2007: 62–113.
- Adams LP, Wilding RJ. A photogrammetric method for monitoring changes in the residual alveolar ridge form. *J Oral Rehabil* 1985; **12**: 443–450.
- Petrokovski J, Massler M. Alveolar ridge resorption following tooth extraction. *J Prosthet Dent* 1967; **17**: 21–27.
- Carlsson GE, Thilander H, Hedegard B. Histologic changes in the upper alveolar process after extractions with or without insertion of an immediate full denture. *Acta Odontol Scand* 1967; **25**: 21–43.
- Andreasen JO, Hämmerle C, Ödman J, Buser D, von Arx T, Jensen J, Nörholt SE, Schwartz O. Implants in the anterior region. In: Andreasen JO, Andreasen FM, Andersson L, eds. *Textbook and Color Atlas of Traumatic Injuries to the Teeth*, 4th Edn. Oxford: Blackwell, 2007: 761–797.