

Orthodontic pre-treatment prior to autotransplantation of palatally impacted maxillary canines: case reports on a new approach

Lena Berglund*, Jüri Kurol* and Sven Kvint**

Departments of *Orthodontics and **Oral Surgery, Institute for Postgraduate Dental Education, Jönköping, Sweden

SUMMARY Impacted maxillary canines in oblique horizontal positions may make orthodontic appliance treatment hazardous or impossible. Autotransplantation may be considered but the removal of the canine is often difficult and since atraumatic removal of the transplant is essential, autotransplantation is then impossible. A new possibility is orthodontic pre-treatment with distal and vertical traction of the impacted maxillary canine to bring the maxillary canine to a more favourable position and facilitate surgical removal and autotransplantation. Eight canines were surgically exposed and pre-treated prior to autotransplantation.

Of 21 autotransplantations of maxillary canines, 20 were successful, among them all eight pre-treated cases. The orthodontic and surgical technique is described and illustrated in two case reports.

Introduction

Impaction of the maxillary canine has been reported in 0.8–2.4 per cent of the European adult population (Andreasen, 1987). Palatal impactions are reported to occur 2–3 times more frequently than buccal ones.

Surgical exposure of impacted canines, often together with orthodontic traction, has long been advocated (von der Heydt, 1975; Andreasen, 1971). Another treatment possibility is autotransplantation of the maxillary canine and this was first reported by Widman in 1915. During the last 25 years a number of authors have reported varying success rates of autotransplantation of maxillary canines (Moss, 1975; Oksala and Kallioniemi, 1977; Azaz *et al.*, 1978; Gardiner, 1979; Hardy, 1982; Ahlberg *et al.*, 1983; Rud, 1985; Schultz and Halle 1989; Lownie *et al.*, 1986; Andreasen, 1992; Schatz *et al.*, 1992). The sometimes poor long-term results may have depended on the endodontic treatment concept, with root canal filling carried out during the operation, thus resulting in longer extra-oral time and trauma to the periodontal ligament. Late endodontic treatment, i.e. performed only after radiographic signs of oste-

itis, also impairs the success rate. The fixation was earlier often rigid with a splint and lasted for a period of 6–10 weeks. More recent long-term reports show that with looser fixation and shorter fixation times, 1–2 weeks, and initiation of endodontic treatment within 4 weeks after transplantation in cases with closed apices, the success rate of autotransplantation of canines does not differ from that of autotransplantation of premolars and exceeds 90 per cent (Oksala, 1974; Gardiner, 1979; Kristerson and Kvint, 1981, 1982; Hardy, 1982; Chambers *et al.*, 1988; Forssell and Oksala 1986, 1988; Sagne and Thilander, 1990; Andreasen, *et al.*, 1990b, c; Schatz and Joho, 1992, 1993).

Of vital importance is that the transplant is removed without damage to the periodontium (Andreasen, 1992). However, the horizontal position of the palatally impacted maxillary canine with the crown close to the apices of the incisors sometimes makes atraumatic removal impossible. For such oblique positions, orthodontic pre-treatment could bring the impacted maxillary canine to a more favourable position and facilitate surgical removal and autotransplantation.

Aim

This report describes and evaluates a method for orthodontic pre-treatment of palatally impacted maxillary canines in oblique positions where atraumatic surgical removal is judged to be hazardous or impossible.

Subjects

From 1984 to 1993, a total of 21 maxillary canines in 19 patients (seven women and 12 men) were autotransplanted at the Department of Oral Surgery, Institute for Postgraduate Dental Education, Jönköping, Sweden, by one oral surgeon. The age of the 19 patients ranged between 10–55 years, with a mean age of 19.5 years. Of the 19 patients, 16 were more than 20 years old.

The 21 canines were palatally impacted in 15 cases and buccally positioned in three cases; in the remaining three cases, the canines were located within the dental arch. In eight cases (in seven individuals), the palatally impacted maxillary canines were judged to have an unfavourable position for autotransplantation. After surgical exposure, they were orthodontically pre-treated by distal movement and uprighting and then autotransplanted. In the pre-treated group the age ranged was 14–20 years (mean age 16.9 years). The mean time for orthodontic

pre-treatment was 7.5 months (range 6–10 months).

Of the 21 canines, 13 needed space opening, among them all the cases in the pre-treated group. The treatment time for space opening ranged from 4–19 months, the mean treatment time being just over 9 months. In two cases the space was gained by extraction of a premolar. Orthodontic treatment with a fixed appliance after the autotransplantation was carried out in three cases. This treatment started 6 months, 2 years and 5 years after the autotransplantation. Six patients received retention appliances. A flow chart of the treatments for the 21 autotransplanted canines is shown in Figure 1.

Methods

Treatment planning in the pre-treated group

From clinical and radiographic examination, often including computed tomography (CT), the orthodontist makes a treatment plan. If in cases with oblique impacted canines conventional orthodontic treatment is declined or not possible, and if the canine is considered important for the occlusion, autotransplantation may be considered. Together with the oral surgeon, a decision is then made as to whether the intended transplant can be atraumatically removed or not.

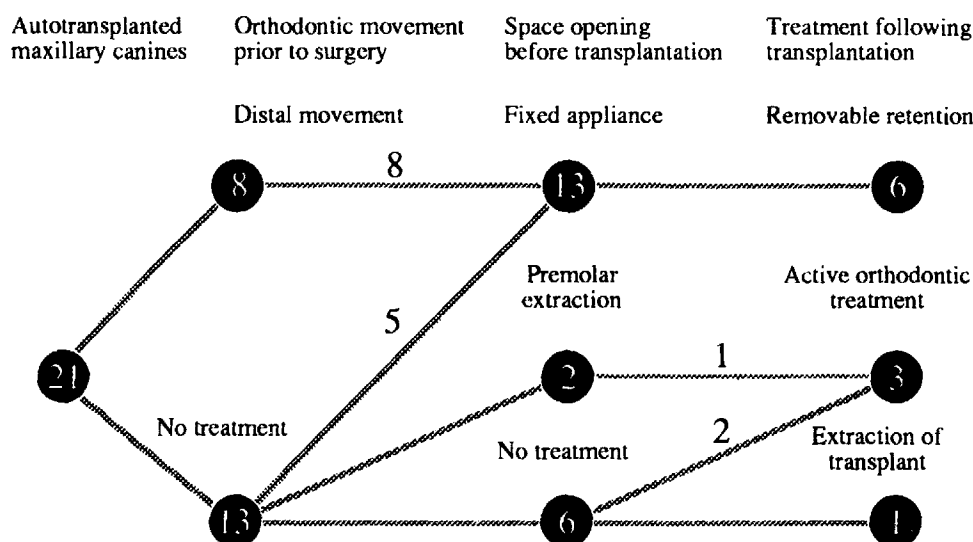


Figure 1 Flow chart of the treatments for the 21 autotransplanted maxillary canines.

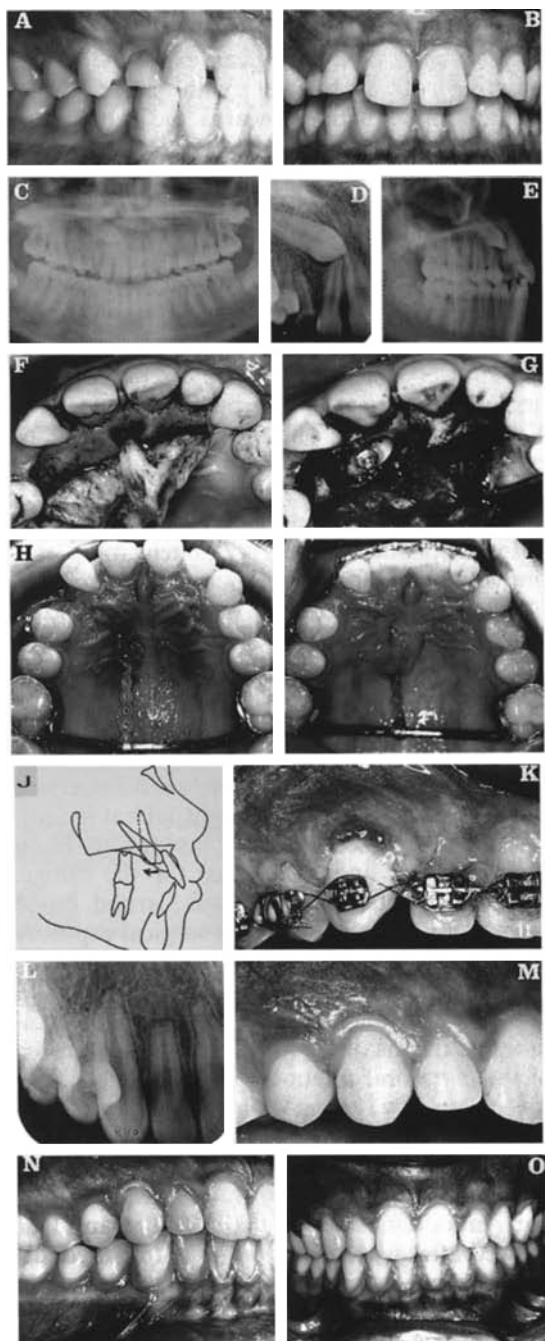


Figure 2 Boy, 13 years 5 months of age at the start with the right maxillary canine impacted. 53 persists. (A, B) Clinical view. (C–E) Radiographs revealing the right canine in an oblique position unfavourable for atraumatic removal and autotransplantation. (F, G) Surgical exposure and bonding of a button to the canine. (H, I) During 6 months the canine was distally moved and uprighted. (J) Lateral head-film tracing showing the uprighting of the canine to a

Orthodontic appliance

If the canine has a position that makes atraumatic surgical removal impossible or hazardous, orthodontic pre-treatment starts with placement of a transpalatal bar soldered to bands on the maxillary permanent first molars. The canine is then surgically exposed and bonded with a button and a silver chain, or a stainless steel ligature wire is extended through the palatal mucosa for traction. Then, an elastic chain from the canine is attached to the transpalatal bar to move the canine away from its oblique position, usually by straight distal traction (Fig. 2H, I). In cases needing space opening for the permanent maxillary canine, this treatment starts about 1 month later with a fixed appliance when the canine crown has been moved away from close contact with the incisors, thus, avoiding the risk of root resorption. When the space opening is completed and the canine has a favourable position for atraumatic removal, the autotransplantation is performed.

Autotransplantation

The operations were performed under local anaesthesia in 18 patients. One patient was treated under general anaesthesia. Premedication was used in one patient (10 + 10 mg Stesolid; Dumex®, Denmark) and one patient was sedated with N₂O.

Before the transplant was luxated, the new alveolus was prepared as completely as possible to a slightly wider socket. The canine was then very carefully luxated and, by making a circumferential incision around the crown, a collar of marginal tissue was secured to the tooth.

If the recipient alveolar site was inadequate the transplant was kept in a dressing with physiological saline while adjusting the new alveolar site. The transplant was then carefully placed in slight subocclusion without bony contact. In none of the cases could the transplant be placed in a bony alveolus. No bone grafts

more favourable position for atraumatic removal. (K) Healing 1 week after autotransplantation with non-rigid fixation. (L) Periapical radiographs 12 months after autotransplantation showing good apical and periodontal conditions for the canine, and normal reactions to electric pulp stimulation. Note the absence of pulp obliteration of the canine and the degree of arrested root resorption of the lateral incisor. (M) Clinical view of the marginal condition of the canine 12 months after autotransplantation. (N, O) Clinical view 18 months after autotransplantation.

were used. The extra-oral time was registered and it ranged from 2–14 minutes, mean 8 minutes.

The fixation was made with surgical sutures in 11 cases or by uniting the canine with the orthodontic appliance with composite or a steel ligature in nine cases. The patient was given penicillin V (Kåvepenin® Astra, Sweden), 1 g b.d. for 7 days, when mouth rinsing with chlorhexidine 0.2 mg/ml was also recommended. The fixation was removed after 1 week, at which time the first check-up radiograph was also made (for a review of the surgical technique, see Andreasen *et al.*, 1990a; Andreasen, 1992).

Of the 21 canines, 16 had closed apices. In teeth with closed apices the endodontic treatment started after approximately 4 weeks with extirpation of the pulp. A calcium hydroxide dressing was placed in the pulp canal for 6 months. The endodontic treatment was then completed with gutta-percha filling of the root canal. In cases with an open apex the chances of revascularization were good and no endodontic treatment was planned unless the check-up radiographs revealed disease.

After clinical control of the healing 1–2 months after autotransplantation, the orthodontic appliances were removed. The need for a retention appliance was judged against the risk of orthodontic relapse.

Follow-up

The mean observation time for the 21 cases was 3 years (range 8 months to 6.5 years). The patients were recalled for clinical and radiographic examination 1, 3 and 5 years after autotransplantation. Registrations were made regarding occlusal contacts, periodontal inflammation and recessions, pocket depth, percussion sound, sensitivity upon electric stimulation and radiographic signs of root resorption, bone height and inflammation in the bone.

Case reports

Case no 1

Boy aged 13 years 5 months at the start of treatment.

Diagnosis

Angle Class I, 13 palatally impacted with the crown close to the incisor roots. Frontal spacing, 53 persisting (Fig. 2A–E).

Treatment plan

Transpalatal arch. Surgical exposure of 13, bonding of a bracket with silver chain. Orthodontic traction towards the transpalatal arch. Fixed appliance in the upper jaw to open up space for 13. Autotransplantation of 13. Retention with a removable plate with extra-oral traction.

Treatment

At the start a tomographic radiographic examination was undertaken to explore the anatomy and reveal any root resorptions (Ericson and Kurol, 1987, 1988). The apex of 12 was resorbed but no damage was visible on 11. After consultation with the oral surgeon about the impossibility of atraumatic removal of the canine for autotransplantation, the treatment plan was drawn up. A transpalatal arch was first placed.

Before the surgical exposure of 13, the space gaining started with bonding of a sectional arch to the upper right premolars. At surgery a button with a ligature wire was bonded to 13 (Fig. 2F, G). With an elastic chain 13 was moved distally towards the transpalatal arch (Fig. 2H). Three months later, when the canine had moved away from the right lateral incisor, the maxillary incisors were bonded to bring them together and gain space for the canine. Autotransplantation of 13 was carried out 6 months and 2 weeks after the surgical exposure (Fig. 2I, J). The sectional arches were removed and the patient received a retention plate with a labial wire and Adams' clasps with buccal tubes on the maxillary first molars. The purpose of the extra-oral traction to the retention plate was to improve the sagittal jaw relation. The patient was not very co-operative, however, and all retention devices were withdrawn after less than 1 year. The canine with an open apex was not endodontically treated. The transplant showed after 6.5 years good periodontal conditions and normal pulpal sensitivity upon electric testing. The expected pulp obliteration did not occur in this case (Fig. 2K–N).

Case no 2

Girl aged 13 years 7 months at the start.

Diagnosis

Angle Class I. Both maxillary canines were impacted palatally in oblique positions high up

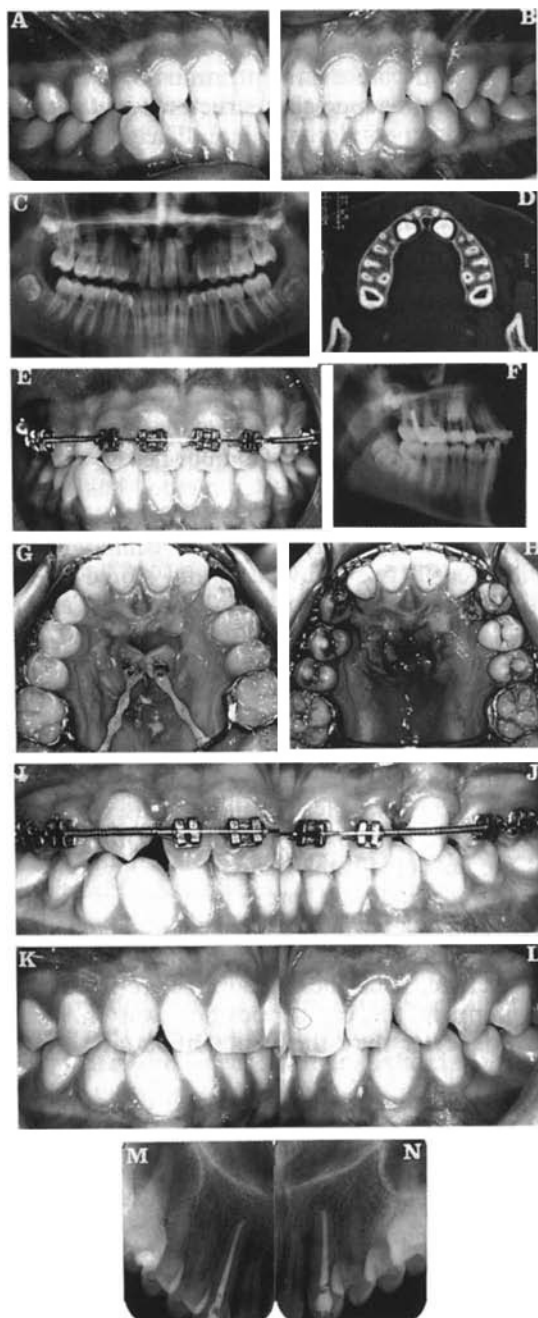


Figure 3 Girl aged 13 years 7 months at the start with both maxillary canines impacted. (A, B) Clinical view with persisting primary canines. (C, D) Orthopantomogram and computed tomography (CT) scan showing the oblique positions of the canines with unfavourable positions for atraumatic removal. (E) Fixed appliance for space opening. (F) Lateral head-film detail with canines in vertical positions now favourable for atraumatic removal. (G) After 6 months of distal movement the canines are ready for autotransplant-

with medially positioned crowns. Frontal crowding was present in both the upper and lower arches; 53 and 63 were persisting (Fig. 3A–D).

Treatment plan

Transpalatal arch. Surgical exposure of 13 and 23. Distal traction of 13 and 23. Fixed appliance in both jaws. Autotransplantation of 13 and 23.

Treatment

Using computed tomography (CT), 13 and 23 were found to be in close contact with 12 and 22 without causing root resorptions; 13 and 23 were judged impossible to extract atraumatically. After consultation with the oral surgeon, the treatment started with a transpalatal bar. Due to excessive bleeding during the surgical exposure, the bonding of brackets had to be postponed until the next visit to the orthodontist, when the sutures were also removed. Elastic chains laced to the transpalatal bar were attached to the bonded hooks on 13 and 23. In less than 6 months the canines were uprighted and distally moved to a favourable position for autotransplantation; regaining space took a further 2 months (Fig. 3E–H).

At the start a fixed appliance was planned for the lower arch for levelling and aligning, but the patient was only interested in getting the maxillary canines to their proper places. She was also not very good at keeping the appliances clean, so it was decided to accept the crowded lower arch.

The treatment time from surgical exposure to autotransplantation was just over 8 months. One month after the autotransplantation the fixed appliances were removed. No retention was judged necessary. Endodontic treatment started 4 weeks after the autotransplantation, and after 6 months with a calcium hydroxide dressing, the root canals were filled with gutta-percha. The canines have been followed for 3

ation. (H) Occlusal view at the end of surgery. (I, J) Clinical view 14 days after autotransplantation. (K, L) 16 months after autotransplantation. 13, 23 with spontaneous completed eruption. (N) Periapical radiographs 1.5 years after surgery where the roots with closed apices have been root filled with good apical and periodontal conditions. Note slight resorption of the distal part of the right lateral incisor root.

years 2 months and show good periodontal and radiographic conditions (Fig. 3I–N).

Results

Of the 21 autotransplantations, 20 (among them the eight pre-treated cases) have been successful. One transplanted canine in a male aged 55 years had to be removed after 8 months due to poor oral hygiene and poor gingival healing with pocket formation.

The 20 successfully autotransplanted canines showed good occlusion and normal gingival conditions with pocket depths below 3 mm. The percussion-sound did not differ from that of the adjacent teeth.

Five of the 20 canines were not endodontically treated and they responded positively to electric testing stimulation. Four of these five teeth showed pulp obliteration. The age of these five patients was 10–14.5 years at the time of surgery. The 15 endodontically treated canines showed no periapical changes. In the pre-treated group all but one received endodontic treatment.

The radiographic check-ups with periapical radiographs showed healed surface resorptions in three cases. No inflammatory or replacement resorption was registered. No post-operative infection was recorded.

Discussion

Surgical exposure and orthodontic traction to move impacted maxillary canines in difficult positions distally into a favourable position for autotransplantation was found to be a new alternative in cases where the canine would otherwise have had to be removed, often in sections. The orthodontic pre-treatment made it possible to save the permanent canine in cases where extraction would not have been a good treatment solution. The optimal developmental stage for autotransplantation is when the transplant has reached 50–75 per cent of its root length (Kristerson, 1985). This stage has almost always passed in cases where autotransplantation of impacted canines is considered. The apex is then in most cases fully formed. Endodontic treatment must therefore in those cases be part of the treatment.

An impacted tooth is one which has failed to erupt within the normal eruption time. The

periodontal space is usually thin in this inactive phase, which is often noticed on radiographs. Orthodontic pre-treatment means organization of the tooth-supporting structures and results in a wider periodontal space. The mobility of the tooth then increases and this also means that atraumatic extraction is easier. This is especially important and favourable in adults, when compared with teenagers who have more elastic bone. Thus, not only is the position of the impacted canine improved by the orthodontic pre-treatment, but the removal is also easier and furthermore the tissues covering the root of the transplant in our experience seem to be thicker and the risk of damage to the periodontal membrane is diminished.

Another kind of two-step method has earlier been described (McBride and Rudge, 1982), where two palatally impacted canines were extracted in two individuals and stored under the mucosa in the vestibulum/buccal fold at the start of the orthodontic space gaining. This two-step procedure was thus performed in cases where the canine could easily be extracted. The purpose was to remove the canine to allow root movements of the neighbouring teeth and space opening without interfering with the impacted canine. Our two-step method focuses instead on oblique positions with difficulty in removal of the impacted canine.

The orthodontic pre-treatment for space opening took 9 months on average. The period for maxillary canine movement was 7.5 months on average. Thus, the orthodontic pre-treatment to improve the canine position was in most cases shorter than the total orthodontic treatment time.

The alignment of an impacted canine is an important task for the orthodontist. The primary canine may persist for many years in adults with impacted canines. However, with the risk of future spontaneous root resorption or infection, the loss of the primary canine can result in serious treatment problems. Firstly, the space in the dental arch is 2 mm smaller than needed for the impacted canine. With no possibility of alignment into the dental arch, a removable prosthesis or bridgework may be necessary, with possible problems with comfort or aesthetics. Due to the heavy masticatory forces in the canine area, prosthetic replacement with a bonded bridge is not recommended. Implants may be a solution but in our opinion autogen-

ous tissue is preferable to alloplastic material. Orthodontic space closure is a very time-consuming treatment and the success depends on many factors, i.e. occlusion, co-operation.

The conventional treatment concept for impacted canines is to expose the tooth surgically and with an orthodontic appliance move the canine into the arch, in most cases with a fixed appliance. The total orthodontic treatment time is long, often 2–3 years, and dependent on many factors besides the position of the canine. From an aesthetic and also economic point of view, this may deter treatment especially for adults (Kurol *et al.* 1996).

In our experience, autotransplanted canines can be placed in a good position with proper angulation. This is not always the case after conventional orthodontic treatment if the impacted canine initially has a palatally deflected root position, hindering proper placement with conventional orthodontic treatment. Sometimes impacted maxillary canines also have an apical deflection which may obstruct or delay the movement. The risk of apical root resorption of the anchoring teeth after a long period of treatment with a fixed orthodontic appliance also has to be considered.

Gingival retraction and a lowered/impaired marginal bone level are also conditions not uncommon after conventional orthodontic treatment. Sometimes orthodontic treatment may also be interrupted due to the patient losing interest and the canine is left without proper root torque. Thus, many negative factors can be avoided with a shorter treatment period using autotransplantation. Autotransplantation may therefore be considered an alternative provided that the success rate is acceptable. The orthodontic pre-treatment described here will further improve the prognosis. Since recent reports show failure rates of less than 10 per cent, autotransplantation may be considered for selected patients with impacted maxillary canines, especially in combination with orthodontic pre-treatment for canines in oblique positions.

Conclusion

In cases where the maxillary canine is in a position making removal impossible or hazardous, orthodontic pre-treatment has proved to be a prerequisite for successful atraumatic removal and autotransplantation of the maxillary canine.

This new approach with orthodontic pre-treatment and autotransplantation of maxillary canines in oblique positions offers a new treatment alternative with a shorter treatment period and fewer visits.

Address for correspondence

Dr Jüri Kurol
Department of Orthodontics
The Institute for Postgraduate Dental
Education
Klubbhusgatan 15
S-553 03 Jönköping
Sweden

References

- Ahlberg K, Bystedt H, Eliasson S, Odenrick L 1983 Long-term evaluation of autotransplanted maxillary canines with completed root formation. *Acta Odontologica Scandinavica* 41: 23–31
- Andreasen G F 1971 A review of the approaches to treatment of impacted maxillary cuspids. *International Journal of Oral Surgery* 31: 479–484
- Andreasen J O 1987 Ectopic eruption of permanent canines eliciting resorption of incisors: treatment by autotransplantation of the canine. *Tandlægebladet* 91: 487–492
- Andreasen J O 1992 Autotransplantation of canines. In: Andreasen J O (ed). *Atlas of replantation and transplantation of teeth*. Chapter 6. Munksgaard, Copenhagen, pp. 196
- Andreasen J O, Paulsen H U, Yu Z, Ahlqvist R, Bayer T, Schwartz O 1990a A long-term study of 370 autotransplanted premolars. Part I. Surgical procedures and standardized techniques for monitoring healing. *European Journal of Orthodontics* 12: 3–14
- Andreasen J O, Paulsen H U, Yu Z, Bayer T, Schwartz O 1990b A long-term study of 370 autotransplanted premolars. Part II. Tooth survival and pulp healing subsequent to transplantation. *European Journal of Orthodontics* 12: 14–24
- Andreasen J O, Paulsen H U, Yu Z, Schwartz O 1990c A long-term study of 370 autotransplanted premolars. Part III. Periodontal healing subsequent to transplantation. *European Journal of Orthodontics* 12: 25–37
- Azaz B, Zilberman Y, Hackak T 1978 Clinical and roentgenographic evaluation of thirty-seven autotransplanted impacted maxillary canines. *Oral Surgery, Oral Medicine, Oral Pathology* 45: 8–16
- Chambers I G, Reade P C, Paker I D 1988 Early post-operative endodontic therapy limits inflammatory root resorption of autotransplanted maxillary canine teeth. *British Journal of Oral and Maxillofacial Surgery* 26: 364–369
- Ericson S, Kurol J 1987 Radiographic examination of ectopically erupting maxillary canines. *American Journal of Orthodontics and Dentofacial Orthopedics* 91: 483–492.

- Ericson S, Kurol J 1988 Resorption of maxillary lateral incisors caused by ectopic eruption of the canines. A clinical and radiographic analysis of predisposing factors. *American Journal of Orthodontics and Dentofacial Orthopedics* 94: 503–513.
- Forssell H, Oksala E 1986 A 10-year follow-up of maxillary canine transplantation. *Proceedings of the Finnish Dental Society* 82: 209–212
- Gardiner G T 1979 The autogenous transplantation of maxillary canine teeth. A review of 100 consecutive cases. *British Dental Journal* 146: 382–385
- Hardy P 1982 Autogenous transplantation of maxillary canines. *British Dental Journal* 153: 183–186
- Heydt von der K 1975 The surgical uncovering and orthodontic positioning of unerupted maxillary canines. *American Journal of Orthodontics* 78: 256–276
- Kristerson L 1985 Autotransplantation of human premolars. *International Journal of Oral Surgery* 14: 200–213
- Kristerson L, Kvint S 1981 Autotransplantation av tänder-10 års erfarenheter. *Tandläkartidningen* 73: 598–606
- Kristerson L, Kvint S 1982 Autotransplantation av tänder- en klinisk behandlingsmetod. *Tidskrift for tandlaeger* 3: 7–14
- Kurol J, Ericson S, Andreason J O 1996 Textbook and color atlas of tooth impactions. Diagnosis, treatment and prevention. Munksgaard, Copenhagen.
- Lownie J F, Cleaton-Jones P E, Fatti P, Lownie M A 1986 Autotransplantation of maxillary canine teeth. A follow-up of 35 cases up to 4 years. *International Journal of Oral and Maxillofacial Surgery* 15: 282–287
- McBride L J, Rudge S J 1982 Two stage maxillary canine transplantation. *British Dental Journal* 68: 363–389
- Moss J P 1975 An orthodontic approach to surgical problems. *American Journal of Orthodontics* 68: 363–389
- Oksala E 1974 Autotransplantation of vital canines. A clinical and radiographic study. *Proceedings of the Finnish Dental Society* 70 (Suppl. I)
- Oksala E, Kallioniemi A 1977 Longitudinal clinical and radiographic study of autotransplantation of the maxillary canine. *Proceedings of the Finnish Dental Society* 73: 117–125
- Rud J 1985 Transplantation of canines. *Tandlægebladet* 89: 399–413
- Sagne S, Lennartsson B, Thilander B 1986 Transalveolar transplantation of maxillary canines. An alternative to orthodontic treatment in adult patients. *American Journal of Orthodontics and Dentofacial Orthopedics* 90: 149–157
- Sagne S, Thilander B 1990 Transalveolar transplantation of maxillary canines. A follow-up study. *European Journal of Orthodontics* 12: 140–147
- Schatz J P, Joho J P 1992 Long-term clinical and radiologic evaluation of autotransplanted teeth. *International Journal of Oral and Maxillofacial Surgery* 21: 271–275
- Schatz J P, Byloff F, Bernard J P, Joho J P 1992 Severely impacted canines: Autotransplantation as an alternative. *The International Journal of Adult Orthodontics and Orthognathic Surgery* 7: 45–54
- Schatz J P, Joho J P 1993 A clinical and radiologic study of, autotransplanted impacted canines. *International Journal of Oral and Maxillofacial Surgery* 22: 342–346
- Schultz S, Halle 1989 Zur Prognose autogener Zahntransplantationen bei der kiefer-orthopädischen Behandlungsplanung. *Fortschritte der Kieferorthopädie* 50: 186–95
- Schwartz P, Bergmann Klausen B 1985 Autotransplantation of human teeth. A life-table analysis of prognostic factors. *International Journal of Oral Surgery* 14: 245–258
- Widman L 1915 Om transplantation av retinerade hörntänder. *Svensk Tandläkartidskrift* 8: 289–296