

Transalveolar transplantation of maxillary canines

A critical evaluation of a clinical procedure

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Regular discussions between the Departments of Oral Surgery and Orthodontics at Göteborg University have resulted in a modified operative technique for impacted maxillary canines, called transalveolar transplantation. After exposure of the operation field, large amounts of bone are removed, avoiding damage to the surface of the cementum and the periodontal membrane. Throughout the surgical procedure the tooth is kept in the alveolar process and then finally gently moved to its desired position. Orthodontic fixation is used to stabilize, not to immobilize, the tooth. So far 101 maxillary canines have been autotransplanted in 85 patients (11-76 years old) with an observation period of 1-17 years. Transalveolar transplantation is considered a good alternative for impacted maxillary canines, provided that the treatment planning is discussed by an orthodontist and an oral surgeon together and the treatment is performed with meticulous surgical techniques and adequately functioning orthodontic fixation and used in patients with proper oral hygiene. □ *Autotransplantation; orthodontics; surgery; oral; tooth; impacted; tooth resorption*

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Impacted maxillary canines are a common reason for referral to both the orthodontist and the oral surgeon. Surgical exposure, with or without subsequent orthodontic treatment, is generally performed in children and adolescents. Adult patients often reject proposed orthodontic treatment because of the relatively long treatment time or because of the visible orthodontic appliance. The traditional treatment in those patients has been surgical removal and prosthodontic replacement. Implants for single-tooth replacement are today a well-known alternative (1). Autotransplantation of teeth has also often been considered an alternative, but the prognosis in cases with complete root formation is questionable (2).

As the results of autotransplantation of impacted canines were not encouraging, it seemed necessary to find alternative treatments in such cases. Regular discussions between oral surgeons and orthodontists at the Odontological Clinic at Göteborg University resulted in modification of the treatment planning in patients with impacted teeth (3). The developed modified operative technique, called transalveolar transplantation, is considered a good alternative to surgical removal in cases of severe malposition of the maxillary canine and when the prognosis of orthodontic treatment is doubtful.

The treatment plan is based on obligatory collaboration between the oral surgeon and the orthodontist, focusing on preoperative space gaining, a modified operative technique, including careful removal of rather large amounts of bone, and use of an orthodontic appliance for the postoperative fixation (4). On the basis

of experience with this method, even canines in very complicated positions or in positions far away from their optimal position in the alveolar process have been successfully treated and presented in a follow-up study (5).

The first patient was treated in accordance with this procedure in 1978. The patient material is continuously increasing, and the method is still the same, although with some minor modifications. This means a gradually growing experience with the method, which will indicate a need for further evaluation of the procedure, its advantages, and any disadvantages.

The aim of this report is to present a critical evaluation of transalveolar transplantation of maxillary canines.

Materials and methods

Patients

The study includes all patients followed up during an observation period of 1-17 years. During this period (1978-94) transalveolar transplantation of 101 maxillary canines in 85 patients (31 males and 54 females) was performed. The age of the patients at the operation varied between 11 and 76 years (mean, 31 years). In 16 of the patients the operation was performed on both sides, in 35 on the right, and in 34 on the left side. In eight of the patients orthodontic extrusion after surgical exposure had been performed during a period of 6-12 months without any, or only a slight, tendency to tooth movement response.

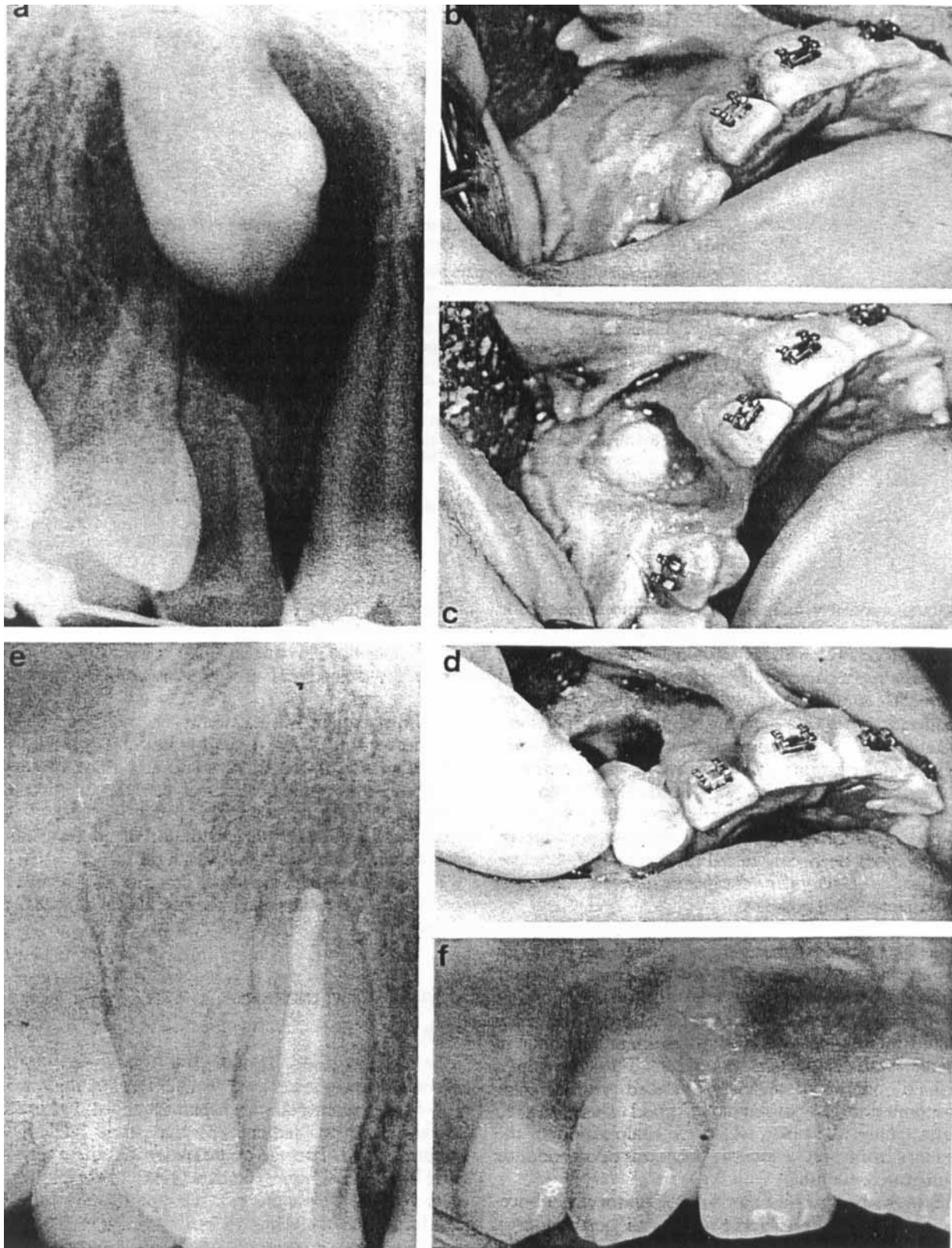


Fig. 1. A 14-year-old girl with an impacted maxillary canine (a). Surgical exposure after flap elevation (b) and removal of bone around the tooth (c), which is moved with fingers to its optimal position (d). Radiographic and clinical situation 3 years later (e, f).

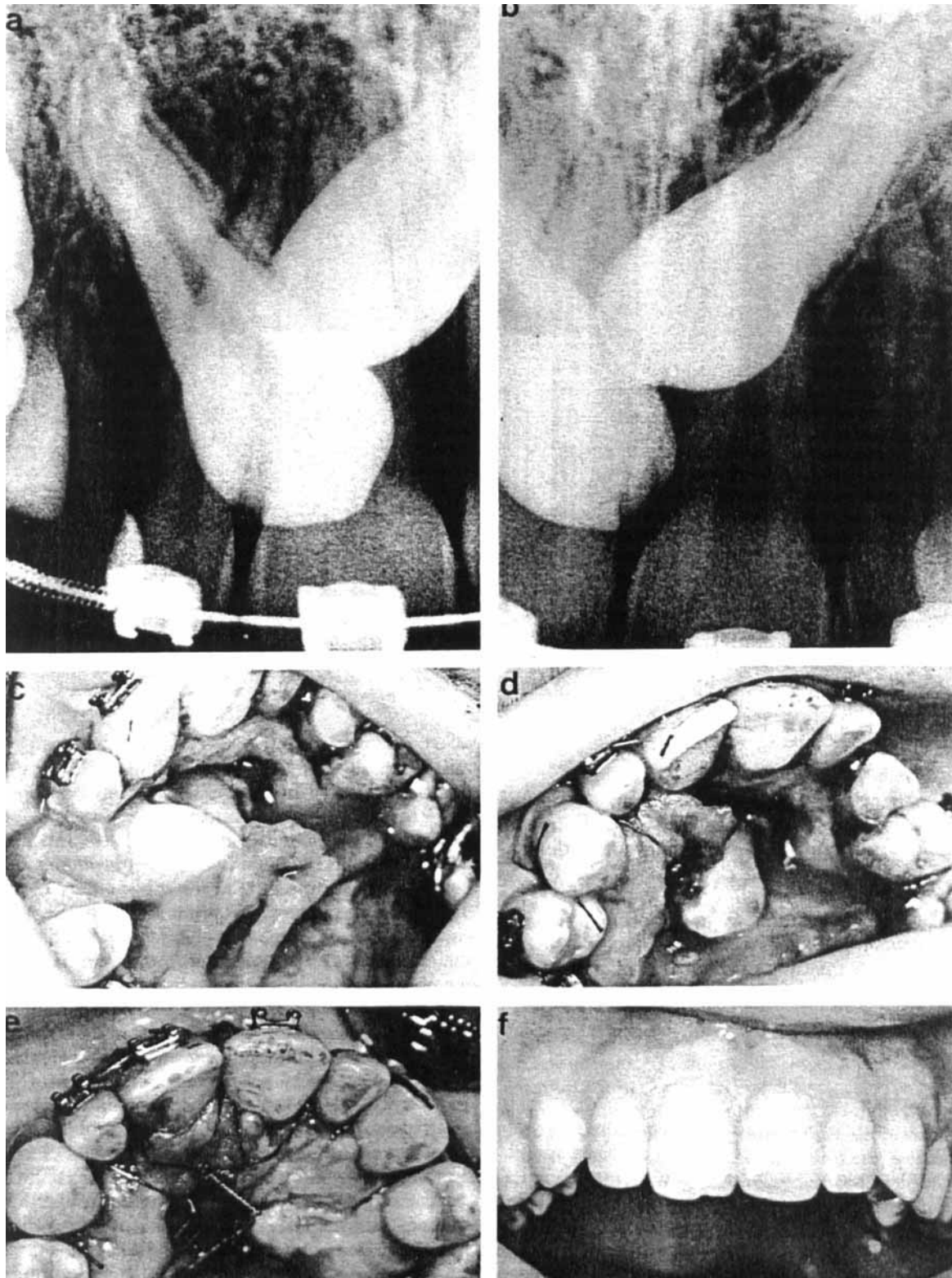


Fig. 2. A 16-year-old girl with both canines fully erupted in palatal positions (a, b). Surgical exposure after a palatal flap elevation and removal of bone (c). The canines moved into their optimal position (d, e). The clinical appearance 5 years later (f).

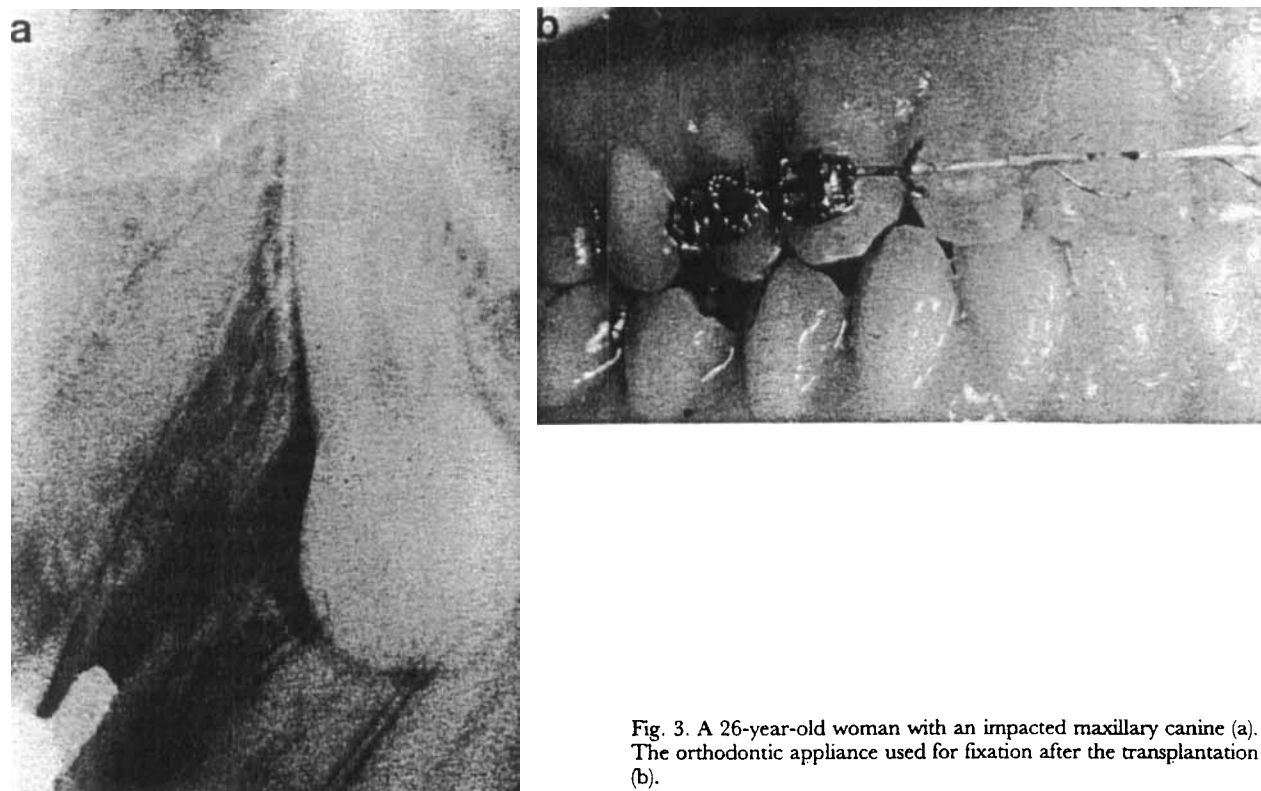


Fig. 3. A 26-year-old woman with an impacted maxillary canine (a). The orthodontic appliance used for fixation after the transplantation (b).

Preoperative procedure

Each patient was examined preoperatively on the same occasion by an orthodontist and an oral surgeon. Radiographic examination, including an orthopantomogram and periapical radiograms, was always performed, with description of the position of the canines and their relation to neighboring teeth and adjacent structures, such as nasal and sinusal cavities. At this examination the final decision was made—that is, transalveolar transplantation or some other therapy.

Surgical procedure

The surgical procedure has been described in previous papers (4, 5). Therefore, only a brief presentation will be given, together with some technical modifications. All operations were performed with the patient under local anesthesia (lignocaine (Xylocaine®)-adrenaline, 20 mg/ml, 12.5 µg) and with good sedation (diazepam, 0.2–0.5 mg/kg body weight). In subjects with bilateral impaction both canines were transplanted during the same operation.

After incision along the gingival margin, including at least one or two neighboring teeth, a surgical flap was

raised buccally or palatally depending on the position of the tooth (Fig. 1). In most cases the flap elevation was performed both buccally and palatally to achieve good exposure of the operative field. Large amounts of bone were carefully removed with a burr under water-cooling, except for a thin layer close to the root surface. This bone was very gently lifted and removed with an elevator. The objective was always to avoid damage to the surface of the cementum and the periodontal membrane.

In many cases an exceptionally large amount of bone had to be removed for cautious detachment of a canine in a complicated position or for teeth with irregular root anatomy or signs of resorption on the crown (Fig. 2). Experience has shown that the alveolar buccal bone plate has to be removed to make it possible to establish the best position and aesthetics.

The tooth was kept in the alveolar process throughout the surgical procedures. The tooth was finally gently moved, with fingers, to its optimal position. In a few cases there was a risk of damaging the root during the final stage of alveolar preparation. The tooth then had to be lifted out, but only for a very brief moment.

Directly after suturing, the fixation was installed by the orthodontist. Postoperative antibiotics for 10 days and analgesics were prescribed.

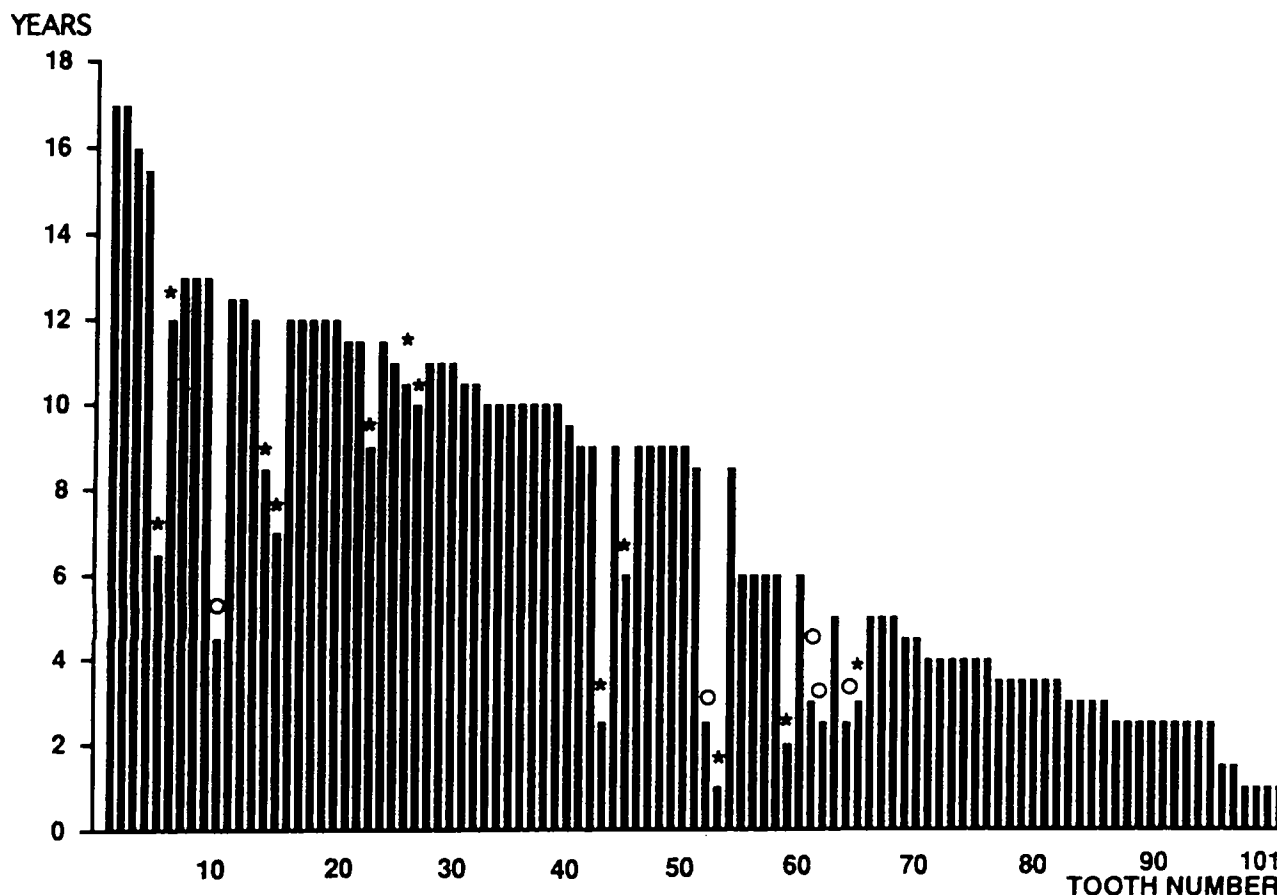


Fig. 4. Graphic presentation of the total material. Each bar indicates one canine during the observation period. Teeth totally or partially extracted are marked with (*). Teeth lost due to loss of patients are indicated with (O).

Orthodontic procedure

In 55 of the 101 teeth orthodontic treatment had to be performed preoperatively because of lack of space in the canine region. The expansion was performed with fixed appliances, which were also used for fixation after the surgical procedure. In the other cases the teeth adjacent to the canine area were bonded by an orthodontist some days before the surgical treatment for direct postoperative use. The extension of the fixed appliance varied, but usually the premolars distal to the canine and sometimes the first molar and/or the incisors were included.

Immediately after surgery a bracket was placed on the canine, and a square sectional arch wire was used for fixation. The purpose was to stabilize, but not immobilize, the transplanted tooth. The canine was thus finally moved into the exact desired position (Fig. 3). Sometimes slight grinding of the antagonist, not of the transplanted canine, was required to avoid interferences in occlusion or during mandibular movements. The orthodontic fixation was used for 3–6 weeks, depending on the amount of bone removed and hence the progressive stabilization of the transplanted tooth.

Endodontic procedure

The endodontic treatment was performed by an endodontist. The first stage (removal of necrotic pulp and installation of calcium hydroxide paste) was performed just after removal of the orthodontic fixation. Within 1 year of the operation the root canal was permanently filled.

Follow-up procedures

Clinical and radiographic examinations of the healing were performed 1 week postoperatively, at the removal of the sutures, and every fortnight during the fixation period. These examinations were then made approximately 2, 6, 12, and 18 months after the operation and then once a year during the first 5 years of follow-up. Thereafter, these checks are performed every 2nd year connected with the routine visits to the general dental practitioner.

Results

All teeth selected for transalveolar transplantation were successfully treated in accordance with the method with

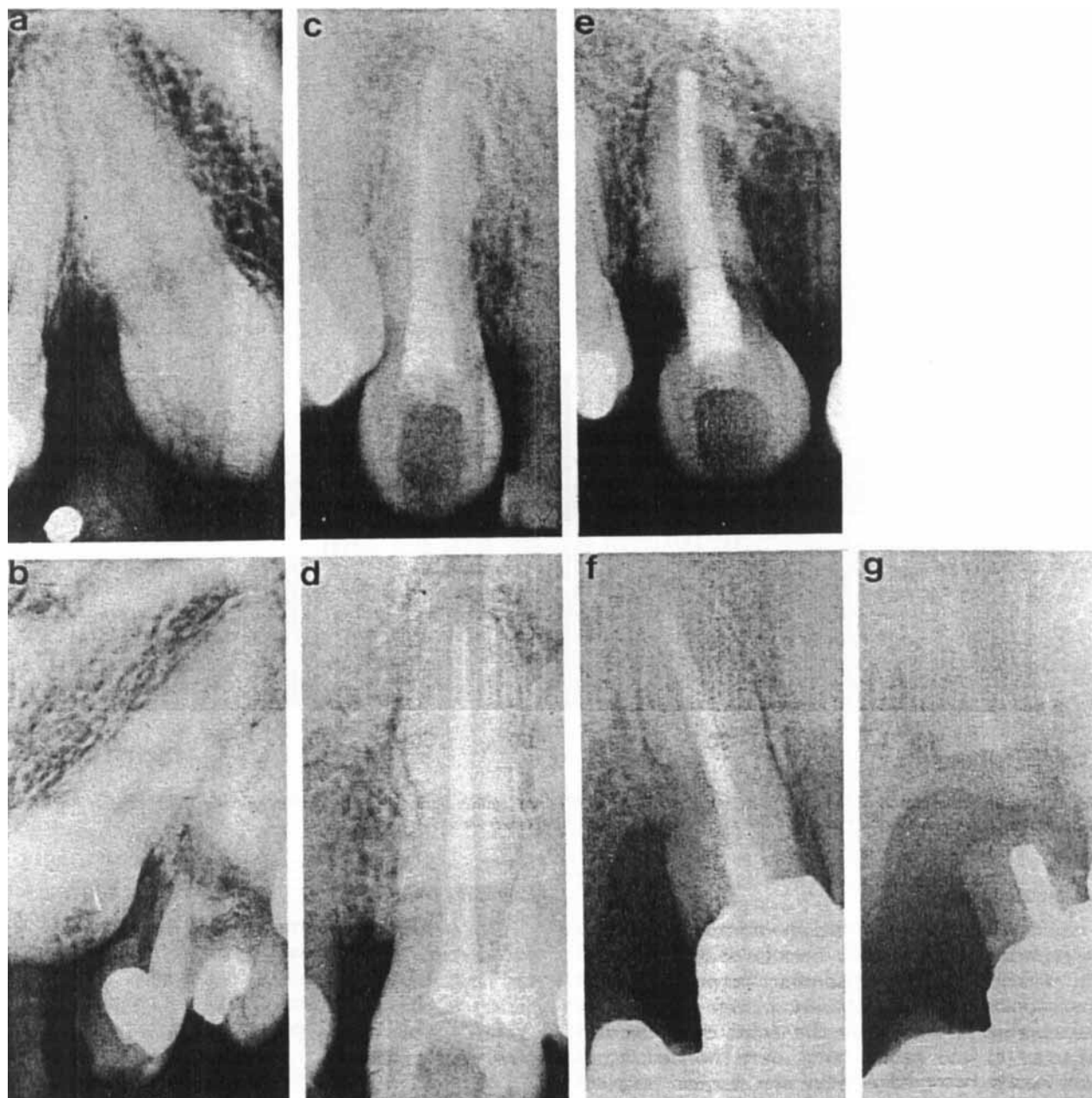


Fig. 5. Teeth 5 and 6 (a, b) in a 33-year-old woman. Radiographs 4 years after transalveolar transplantation show good healing (c). Six years after operation resorptive cavities are observed (d, e), especially in the right one, which was extracted. Status for the left canine after 10 years (f) and 14 years (g).

a good aesthetic result. Owing to the preoperative orthodontic treatment, it was no problem for the surgeon to place the canine in its optimal position in the dental arch. In a few cases, however, the tooth had to be placed in a rotated position or slightly buccally.

No postoperative complications, such as infection or severe pain, were observed. The orthodontic fixation was well accepted by the patients. When the appliance

was removed (3–6 weeks postoperatively) the teeth were in general rather stable.

The appearance of the mucosa around the transplanted tooth did not differ from that of the adjacent teeth. An attached gingiva with a stippled surface buccally and a pocket depth of 2–4 mm was regularly observed, as illustrated in Figs. 1f and 2f. This very good aesthetic appearance was observed even at the follow-

up visits, 5–15 years postoperatively. Neither the operative technique nor the amount of bone removed influenced the periodontal conditions.

The first postoperative radiographic examinations showed signs of bone healing at the periphery of the bone cavity, but during the healing period a separate bone contour around the root surface was also observed. The bone healing was in most cases completed 1–1.5 years postoperatively with a periodontal space visible around the root, illustrated in Fig. 1e. The age of the patient did not influence the healing period, which, however, was slightly prolonged in case of abundant removal of alveolar bone. In a few cases minor permanent bone cavities were observed, indicating scar tissue formation, which did not influence the long-term result.

All the 101 transplanted canines, indicated as individual bars during the postoperative follow-up period, are presented in Fig. 4. During the observation period (1–17 years) 5 of the 85 patients were lost (5 canines, marked with ○ in Fig. 4); one died, three moved a long distance from our region, and one could not be traced. At their latest control visit (2.5–4 years postoperatively) the transplanted canines were in good condition. Twelve teeth (marked *) have been totally or partially removed due to complications, most of them after many years (mean, 6.5 years; range, 1–12 years).

In one patient (tooth 43) insertion of osseointegrated implants 2.5 years after the transplantation was performed for full denture prosthodontics at another clinic, and the transplanted canine, still in good condition, was extracted. In three patients complications due to periodontal infections were observed. In two of them (teeth 53 and 59) plaque retention resulted in delay of the bone healing, and deep gingival pockets were established, and the canines had to be extracted 1 and 2 years, respectively, after operation. In one patient (tooth 26) the bone healing mesially of the tooth was delayed, and a deep gingival pocket was established some years after the operation. There were good conditions around the rest of the root, and the tooth was very stable. A tendency to acute infections and plans for an upper front teeth bridge construction led to the extraction 10.5 years postoperatively. It may be noted that these patients already had a poor oral hygiene status at the time of operation and should therefore have been excluded from transplantation therapy.

The eight remaining teeth were lost due to resorption in general at the cemento-enamel junction (CEJ). It is of interest to present these cases in more detail.

Teeth 5 and 6

The patient, a 33-year-old woman, underwent transplantation of both canines (Fig. 5). At the control, 6 years postoperatively, the radiographs showed external root resorption at the cemento-enamel junction,

especially in the right canine. This tooth had to be extracted 6 months later. In the left canine, now included in a prosthesis bridge, the resorptive process proceeded slowly. Surgical exposure of the area 10 years postoperatively showed marked bone growth close to the defect and even into the defect itself. The resorption proceeded despite filling of the defect, and the coronal part of the left canine was extracted 12 years postoperatively. The rest of the root is firmly fixed and shows no signs of resorption. No explanation of the losses can be given, except the previous speculation about tooth bleaching with hydrogen peroxide (5).

Tooth 14

A 35-year-old man was subjected to transplantation of the left canine. At the control 8.5 years later, resorption was observed in the same area as described for teeth 5 and 6. The tooth had to be extracted. No explanation of the tooth loss can be given.

Tooth 15

A 40-year-old woman underwent transplantation of both canines. At the control 7 years later, the right canine displayed resorption, as described for teeth 5 and 6. Exploration and an attempt to stop the resorption with a filling was unsuccessful, and hence the tooth was extracted. The left canine, however, was in good condition and still was at the last control (11.5 years postoperatively). No explanation of the loss of the right canine, in contrast to the left healthy one, has been found.

Tooth 23

A 31-year-old woman underwent transplantation of the right canine. At the control 9 years later the tooth had to be extracted owing to resorption close to the CEJ. The only possible explanation of the tooth loss is grinding of the canine directly after operation, due to interferences.

Tooth 27

A 48-year-old woman underwent transplantation of both canines. The teeth showed advanced resorption of the crowns preoperatively, and especially in the right one. Although the teeth were firmly fixed in bone, the operation was successful, and both teeth could be transplanted into good positions, and one was later provided with a crown. Nevertheless, resorption on the root surface of the right canine was observed near the CEJ. The patient's dentist tried in vain to fill the cavity, and the tooth had to be extracted 10 years postoperatively. The left canine is still functioning without any resorption tendency.

Tooth 45

A 19-year-old woman was subjected to transplantation of the right canine. Because of external root

resorption close to the CEJ, the tooth was extracted 6 years later. Before the transplantation the canine had been surgically exposed and orthodontically extruded. The tooth was originally impacted deep in the alveolar process in a palatal position. As its response to the orthodontic forces was slow, the orthodontic treatment was changed to the surgical procedure 14 months later. It may be speculated whether the previous surgical-orthodontic treatment may have caused the resorption, even 6 years after the transplantation.

Tooth 65

A 46-year-old man underwent transplantation of the left canine. The tooth was extracted 3.5 years later due to external root resorption. No explanation of the tooth loss can be given, apart from previously performed surgical exposure and orthodontic extrusion with a slow tissue response.

Discussion

This study is a critical evaluation of a method for treatment of impacted maxillary canines, called transalveolar transplantation. Of 101 transplanted canines, 82 have been followed up for more than 3 years. Patients observed only during a shorter period of 1–2 years are also included in the study for continuous assessment of the advantages of the procedures.

The study shows encouraging results. The patients are very satisfied with both the aesthetics and the 'own tooth feeling', a further advantage of the method. It must be stressed that many of the transplanted teeth were impacted in complicated positions, especially in the children, and that no alternative treatments—other than removal—were possible. Teeth in complicated positions can gently be made free from bone, mobilized, and moved to the new position. Thus, there seems to be no limitation with regard to the amount of bone that can be removed during the operation. In some of the cases included in this material, there was no bone left buccal or palatal to the new tooth position, but in spite of this bone healing was good and rapid.

It should be noted that the results are based on conventional clinical and radiographic observations. However, according to the long-term observations, neither single discrepancies such as minor apical bone defects or slight irregularities of the root surface nor limited gingival pocket deepening seems to affect the final result.

Some complications were observed during the observation period, however. Efforts have been made to analyze the cause of the complications. The amount

of bone removed, the preoperative position of the tooth, or the duration of fixation does not seem to influence the final prognosis. Periodontal disease or difficulties in establishing good oral hygiene give a higher tendency to failure, however. These complications were observed early and are the reason for the extractions before 2 years.

A surprising finding was the late resorption cavities resulting in tooth loss up to 12 years postoperatively. During exploration of some of the cavities very good bone healing close to the resorption and a tendency to ingrowth of bone was observed. These observations are indicative of a complex inflammatory reaction.

Important for the success of the transalveolar transplantation is the close collaboration between the oral surgeon and the orthodontist in treatment planning. In many cases space gaining was performed in accordance with well-known orthodontic principles. It is thus important that the surgeon has enough space to place the transplanted tooth in an aesthetically and functionally good position.

Conclusions

Transalveolar transplantation is considered a good treatment alternative for impacted maxillary canines, provided that the treatment planning is discussed by an orthodontist and an oral surgeon together, the treatment is performed with a meticulous surgical technique, properly functioning orthodontic fixation is used, and it is used in patients with proper oral hygiene.

The method is thus a good alternative to orthodontic treatment in adult patients who refuse a long period of treatment with orthodontic appliances. In cases of malpositioned canines, the method seems to be superior to surgical removal and prosthodontic replacement, especially in children and adolescents.

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