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# Autotransplantation in combination with orthodontic treatment

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## Abstract:

**INTRODUCTION:** Autotransplantation is a surgical method in which a tooth is repositioned within the same patient. It can be described as a controlled reimplantation of an extracted tooth into a new, surgically prepared socket. The key to success of this treatment is the preservation and regeneration of the periodontal ligament. It is an underutilized technique which, if conducted with a multidisciplinary team, can be an ideal treatment option for patients with failing or missing teeth.

**OBJECTIVES:** The detailed clinical procedures, indications for this technique, and the factors affecting its success are discussed.

## Keywords:

Autotransplantation, recipient site, reimplantation, success rate

## Introduction

Teeth that are missing for any reason represent a problem for orthodontists, who must decide whether the space(s) should be orthodontically closed, prepared for prostheses or implants, or prepared for transplant. Although restorative techniques have been improved dramatically, a review of the literature shows that failure rates of resin-bonded bridges ranged from 10% over 11 years to 54% over 11 months.<sup>[1]</sup> The use of osseointegrated implants is contraindicated on growing patients, despite their increased use in patients with missing teeth, as they will remain infraoccluded due to ankylosis to the alveolar bone.<sup>[2]</sup> Therefore, to compensate for the poor aesthetic results produced by subsequent alveolar bone growth, further consideration of the potential of using autogenous transplanted teeth in children is required.

When a patient with missing teeth seeks orthodontic treatment for aesthetic reasons,

the treatment plan should be based on a comprehensive evaluation of patient age, occlusion, space requirements, and the shape and size of adjacent teeth.<sup>[3]</sup> The orthodontist is then left with several options regarding the space:

- **Space closure:** this has many advantages, as it eliminates prosthetic replacement and problems linked to compromised general health and costs less over the long run. Most importantly, this approach preserved the alveolar ridge height.<sup>[4]</sup> However, depending on which tooth is missing, the actual results differ. Orthodontic space closure of a missing upper central incisor often produces unappealing aesthetic results, because the dental asymmetry would be obvious and poor gingival contour would be caused by the decreased cervical width and height of the lateral incisor in comparison to the central incisor. As to closing the space of a missing lateral incisor, mesializing the canine to close the space poses problems because the canine is needed for canine guidance of lateral jaw excursions in dynamic functional occlusion. The canine often needs some

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- restorative modification to its morphology, color, and gingival contour to simulate the lateral incisor<sup>[5]</sup>
- Space opening: a partially closed space will require orthodontic reopening to receive a fixed or removable prosthesis, an implant, or a transplant. The space opening option is favorable in Class I malocclusion in case of a missing incisor with the presence of good buccal interdigitation. It has many advantages over space closure, such as simpler orthodontic mechanics, creation of functional occlusion, and improved aesthetics<sup>[6]</sup>
- Autotransplantation: this process is defined as the transplantation of an embedded, impacted, or erupted tooth from one site to another in the same person, either into an extraction site or a surgically prepared socket.<sup>[7]</sup> The first clinical case reports of successful autotransplantation appeared in the 1950s, in which carious first molars were replaced by transplanted immature third molars<sup>[8]</sup>

### History and Definition

Autotransplanting human teeth has been carried out since ancient times. However, most of these cases' results were unsatisfactory due to a lack of knowledge about preventing infection. Advances in modern medicine have greatly improved the probability of successful results in autotransplantation through a better understanding of the healing process of periodontal tissue and dental pulp and the mechanism of root resorption.<sup>[9]</sup>

In orthodontic practice, teeth that are occasionally extracted for discrepancy problems could be used as donors to a recipient region, so autotransplantation has become one of the primary treatment options to replace

missing teeth [Figure 1]. Although many publications have reported a 90% survival rate of transplanted teeth, there are still undesirable outcomes such as dentoalveolar ankylosis or root resorption, especially in teeth with complete root formation. Therefore, appropriate precautions are needed to achieve a better prognosis.

### Autotransplantations versus osseointegrated implants

Recently, single-standing implants have been found to be a reliable substitute for missing teeth. However, due to the osseointegration of implants, disturbance in jaw growth will occur if implants are installed before the cessation of alveolar growth. Thus, implants used to replace teeth in the premolar region in aplasia cases will act as ankylosed deciduous molars with known complications. On the other hand, autotransplanted premolars will trigger alveolar growth along with the eruption process; this process is currently under investigation. The patient's age and teeth with incomplete root formation available to be transplanted is therefore decisive when choosing between implants and autotransplanted teeth.<sup>[10]</sup>

### Clinical Considerations

Although several indications and contraindications are obvious to seasoned practitioners, attention must be paid to each step of the procedure to achieve an optimal result.

### Source of transplants

Any tooth within the patient's dentition might be a candidate for transplantation, but third molars have been most frequently used, for several reasons. These teeth, which are otherwise often extracted, have served well as replacements for cariously destroyed first molars. Moreover, their root development, which continues into the late teens and twenties, makes them suitable for use into adulthood. Premolars have also been readily available as transplants, especially since their extraction is often indicated in the orthodontic treatment plan. Furthermore, their anatomy is frequently better suited to mesial replacement [Figure 1]. Lower incisors have been used to replace upper lateral incisors, and impacted canines have been surgically repositioned in extreme cases.

### Size of transplant

During donor selection, consideration should be given to the size of the recipient area. Mesiodistal assessment is easily executed, but it is typically difficult to determine the labiolingual width of a donor root and whether it can fit well within the alveolar walls. For such assessments, occlusal radiographs are usually recommended. Depending on the space available, the premolar's limited size may make it a more favorable candidate than a third



Figure 1: Pre- (a) and posttreatment (b) photographs of a patient; the arrows indicate the donor tooth and the tooth after transplantation

molar. On the other hand, the last tooth in the arch may offer better access for removal, and it is crucial that the root remain sound and undamaged during relocation.

### Timing of transplant

Since the main objective is to obtain the maximum root length of the transplant, timing is critical for several reasons. Slagsvold and Bjercke found that enamel calcification can be adversely affected if transplantation is performed near the time of completion of crown formation. On the other hand, the likelihood of a successful prognosis is reduced as the root apex reaches closure. The fact that revascularization must take place should always be taken into consideration.<sup>[11]</sup> While Fong and Agnew noted a reestablishment of blood supply within a closed apex, this is more easily achieved at an earlier stage.<sup>[12]</sup> Surgical manipulation of a tooth in the bud stage of development is a traumatic event, and further development from that point onward may not be normal. Postoperative root formation is often inhibited or may take on morphologic abnormalities.

Moreover, studies have shown a significant reduction in final root length when compared with the contralateral side, while postoperative resorption is rarely reported. It is thought that allowing adequate development prior to transplantation minimizes the reduction in root length. On the other hand, the longer the root at the time of surgical intervention, the greater the depth needed at the recipient site. Care must be taken not to encroach upon the maxillary sinus or the mandibular canal. Since it is desirable to reposition the tooth out of occlusion and subsequently allow it to erupt to contact its antagonist, additional socket depth preparation may be required. Hale stated that “the length of the root of a developing dental transplant depends on the degree of preparation of apical depth of the placement at the time of surgery”; like many authors, Hale believed that the most favorable time for transplantation was at root formation of 3–5 mm.<sup>[13]</sup> Some research has confirmed the need for delaying transplantation until after furcation formation. Many investigators have contended that results will be maximized if the operation is performed when root formation is one-third to three-fourths complete, but Slagsvold and Bjercke presented successful premolar transplants at all stages of root formation. The genetic potential of a properly handled transplant can sometimes lead to a response that exceeds the expected.<sup>[14]</sup> While we generally agree with the theory advanced by Hale, especially from the perspective of objectives and treatment plan timing, the developing tooth has the potential for apical bony displacement and root elongation.<sup>[13]</sup>

Timing can also have a bearing on the recipient site. Proper alveolar architecture is essential for housing the

transplant. If the recipient site is edentulous, the alveolar contour will often be underdeveloped (or sometimes non-existent), making the procedure inadvisable.

The maintenance of deciduous teeth in these areas becomes very important. If replacement is planned, these teeth should be kept free from pathologic processes, and it is desirable to delay extraction until the time of transplantation, as the extraction site provides the basis of a crypt for placement.

### Recipient site

Our primary concern in the selection of a recipient site is periodontal integrity. In this regard, a suitable site must have sufficient alveolar support in all dimensions; it should be covered with adequate attached, keratinized tissue to allow proper coverage or approximation to the transplant. It should also be free of chronic inflammation, and, as we discuss below, there should be minimal manipulation of the transplant.

Bearing this in mind, we suggest that mesiodistal space deficiencies be eliminated prior to the surgical procedure, either by orthodontic means or by slicing of adjacent teeth. In addition, there should be adequate labiolingual width on the ridge to accommodate alveolar plates on both surfaces. The proper depth of preparation can be tested by trial insertion of a “dummy” tooth that can be replicated in advance to precise dimensions by long-cone and occlusal radiography. With fit and depth of cavity preparation assured in this way, the transplant can be moved without delay from the donor site directly to the recipient field. If the transplant is too small, Costich recommends the filling in of “dead space” with bony fragments. While this technique is not universally advocated and ideally should not be necessary, these fragments could be prepared in advance if their use is anticipated.<sup>[15]</sup> Nordenram and Bergman disclosed better results in the maxilla than in the mandible, but they are the only authors to find a preferred region for transplantation.<sup>[16]</sup> It has also been our experience that the maxillary sinus tends to limit the potential size of the socket to be created and thus the prognosis in this arch.

## Clinical Situations in Which Autotransplantation May Have a Role

### Trauma

Maxillary incisors are the teeth most affected by traumatic injuries. Many reports show that premolars have been used to replace missing upper central incisors in crowded dentition.<sup>[17]</sup> Autotransplantation maintains or restores alveolar bone volume, thus producing aesthetically pleasing results [Figure 2].<sup>[18]</sup> A future single-tooth implant may be placed after growth cessation, but this is often impossible to achieve if the alveolus atrophies beneath a prosthesis

### Impacted or ectopic teeth

Autotransplantation is a simple and fast treatment option for patients with ectopic teeth, especially among adults, who often reject the idea of wearing an appliance to align an ectopic tooth.

### Replacement of a developmentally absent tooth

The most commonly reported missing teeth are mandibular second premolars and maxillary second molars.<sup>[19]</sup> Premolars in a crowded arch might be transplanted to another site where the premolars are missing [Figures 3 and 4].<sup>[20,21]</sup> Moreover, autotransplantation of teeth has been used in the dentoalveolar rehabilitation of cleft patients; when performed in the cleft site, it actually provided a functional stimulation of the new alveolar bone, thereby preventing atrophy of the graft.<sup>[22]</sup> However, the long-term prognosis of tooth transplantation in the cleft has not yet been established.<sup>[23]</sup> Autotransplantation has also proven useful in treating patients with cleidocranial dysplasia who present late for treatment and are too old to expect spontaneous eruption. Up to 14 permanent teeth transplantation have been carried out in a single individual.<sup>[24,25]</sup>

### Teeth with poor prognosis

The most frequent tooth to be extracted (due to periodontal disease or carious) is the first permanent molar. In this case, transplantation of the third molar or a premolar can be considered.

### Tooth Selection

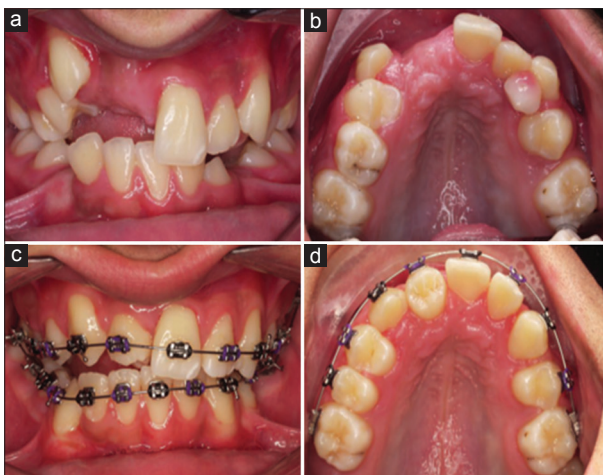
Premolars, canines, incisors (especially supplemental teeth), and third molars are the teeth most commonly used for autotransplantation.<sup>[7]</sup> Premolars have been suggested as particularly suitable for use

as replacements in the upper incisor region.<sup>[14]</sup> Mandibular first premolars are the teeth of choice for transplantation to the maxillary incisor region because of their favorable morphology, size, and single root canal. Some restorative techniques – porcelain veneers, composites, or crowns – can be used to modify premolars and make them simulate incisor teeth, and in some cases the enamel of the palatal cusp of the premolar can be reduced to prevent occlusal interferences.

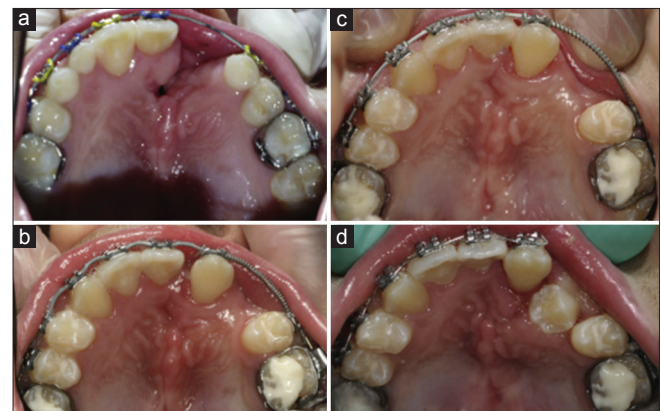
### Surgical Technique

Good oral hygiene, self-motivation, and a medical history not contraindicating transplantation are prerequisites to initiating this treatment step. Regardless of the surgical technique undertaken, a careful atraumatic surgical procedure is essential to preserving the intact periodontal ligament (PDL) to the greatest degree possible. If Hertwig's tooth sheath is traumatized, then future root growth is limited or inhibited depending on the severity of the trauma.<sup>[26]</sup>

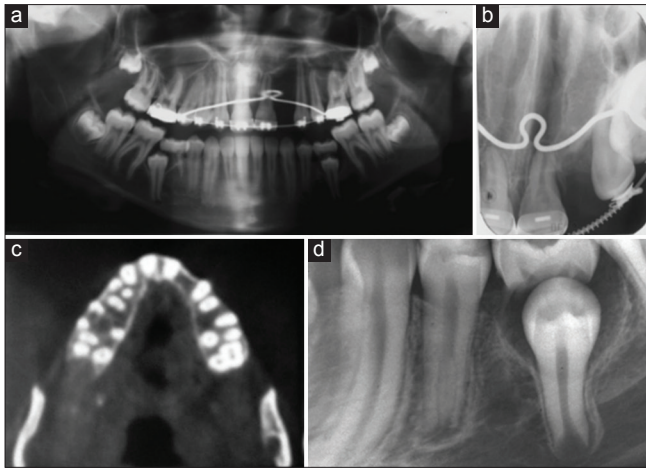
In some situations, autotransplantation may not be possible as a one-stage procedure. Two-stage transplantation is reported in cases of ectopic canine, where the canine is removed initially and stored in the buccal pouch until the recipient site is orthodontically prepared.<sup>[27]</sup> In certain other cases, alveolar bone grafting of the recipient site may be required prior to transplantation, because of alveolar ridge resorption with insufficient buccopalatal width to accommodate the transplant. This can be evaluated by specialized investigative techniques such as the SCANORA imaging software or computed tomography imaging.



**Figure 2:** (a and b) Pediatric patient with traumatic loss of upper right central and lateral incisor in bicycle accident. (c and d) Autotransplant of lower right first premolar into position of upper right central incisor (*British Dental Journal*)<sup>[18]</sup>



**Figure 3:** (a) Palatal occlusal view of the widened alveolar cleft after orthodontic preparatory stage of premaxillary expansion and protraction. (b) Postsurgical bone grafting with maxillary left canine eruption in grafted alveolar cleft area in a mesioangular position. (c) Maxillary canine orthodontically drifted into alveolar grafted area with a distal contact point with maxillary left central incisor creating adequate space for donor tooth transplantation next to the cleft area. (d) Post-autotransplantation intervention (*Journal of Cranio-Maxillo-Facial Surgery*)<sup>[22]</sup>



**Figure 4:** Radiographic evaluation of cleft affected candidate for autotransplantation. View of the recipient (maxillary left lateral incisor) and donor site (mandibular left second premolar), revealing mandibular premolar root development that exceeds two-thirds of the complete root length – the appropriate dental age for autotransplantation procedures. (a) Panoramic radiograph. (b) Periapical radiograph of recipient site. (c) Postsurgical bone graft and pre-autotransplantation intervention – CBCT view. (d) Periapical radiograph of the donor site. (*Journal of Cranio-Maxillo-Facial Surgery*)<sup>[22]</sup>

## Splinting

After the donor tooth has been transplanted, it is usually held in place to promote periodontal healing and avoid inflammatory root resorption due to occlusal trauma. However, rigid long-term fixation of transplanted teeth may have adverse effects on periodontal and pulpal healing and cause ankylosis.<sup>[28]</sup> Most studies advise flexible splinting for 7–10 days, as this allows for some functional movement of the transplant. This movement has been suggested to stimulate PDL cellular activity and bone repair.<sup>[29]</sup> Splinting is not essential in autotransplantation, although it appears to be beneficial in most situations.<sup>[30]</sup> In some cases, a suture crossing the occlusal surface can be used for stabilization of the transplanted tooth; on the other hand, when stability is doubted in traumatic situations, bonded wires may be used for fixation for 1–2 weeks when premolars are transplanted into the incisor region.<sup>[31]</sup>

## Pulpal Healing and Endodontic Treatment

Pulpal healing can be monitored with either pulpal sensitivity or radiographic signs of pulp canal obliteration. In most teeth transplanted in stages 3–4, both events were observed, with only a few teeth showing only one sign or the other. These results accord with the conclusions reported by Andreasen *et al.*<sup>[26]</sup> As transplantation of teeth implies severance of the vascular and nervous supply to the pulp, serious damage can be anticipated to the architecture and function of the pulp. Subsequent healing processes

usually restore the content of the pulp canal, including the nervous supply. Pulpal sensitivity without pulp canal obliteration may take place in rare cases; likewise, pulp canal obliteration without pulp sensitivity may occur when nerve regeneration fails. Teeth showing early reinnervation and no or only partial pulp canal obliteration appear to result from fast pulp canal revascularization, that is, end-to-end anastomoses of ruptured vessels. Autotransplantation can have complications such as loss of pulp vitality, poor periodontal healing, and root resorption, which can be minimized if mature transplants are root filled within 4 weeks of transplantation.<sup>[32,33]</sup>

Andreasen *et al.* (1990) demonstrated the following regarding transplanted premolar teeth:

- Those with incomplete root formation had a 95% survival rate
- Those with complete root formation that was endodontically treated at 4 weeks had a 98% survival rate
- Extra-alveolar endodontic treatment carried at the time of transplantation increased the risk of subsequent root resorption, as the root sheath is damaged during handling.<sup>[33]</sup>

A successful transplantation is achieved when a tooth undergoes normal periapical healing with neither inflammatory pulpal changes nor progressive root resorption and experiences continued root development to maintain tooth function.<sup>[20]</sup>

In a study conducted to observe pulpal and periodontal healing, root development, and root resorption subsequent to transplantation and orthodontic rotation, autotransplantation was combined with orthodontics. The following results were found:

- Pulpal healing evaluated radiographically by the first evidence of pulp canal obliteration appeared to be an earlier sign of pulp healing than electrometric pulp testing
- Continued root growth of premolars was typical.
- Arrest of root development was usually followed by development of the missing root structure at the donor site
- Orthodontic rotation induced a slight surface resorption and a significantly shorter tooth length (mean, 1.2 ram), with a few cases showing late pulp necrosis
- To prevent interference with graft healing by orthodontic rotation, it was suggested that such treatment be postponed until after pulpal and periodontal healing has taken place and before total pulp canal obliteration, that is, 3–9 months after transplantation.<sup>[10]</sup>

## Factors Contributing to the Success of Autotransplantation

### Root maturity at transplantation

There is a high success rate when transplanting teeth with immature roots. The best prognosis has been found with development of half to three-quarters of the transplanted tooth's root.<sup>[20]</sup> Another study by Lagerström and Kristerson revealed a success rate of 87% for teeth with immature roots and 67% for teeth with mature roots when they are not root-filled.<sup>[31]</sup> Similarly, an evaluation of transplants to the maxillary incisor region showed a 96% survival rate with immature roots, while teeth with mature roots had an 82% survival rate.<sup>[34]</sup> Although most studies suggest a greater success rate for teeth with immature roots, these teeth showed less posttransplant root growth than transplanted teeth with more mature apices.<sup>[33]</sup> Most studies show that successfully transplanted teeth have a small and usually insignificant reduction in final root length; for example, premolar transplants with immature roots have a reduction in root growth of up to 1.3 mm on average.<sup>[35]</sup>

A few studies have reported the effect of orthodontic movement on transplanted teeth. Lagerström and Kristerson studied the effect of orthodontic treatment on root development of autotransplanted premolars; they compared transplanted premolars that were orthodontically treated beginning 6 months after transplantation with transplanted premolars that did not receive orthodontic treatment, with contralateral teeth in both groups serving as controls. They found no statistically significant difference between the original and final root lengths of the transplants in the two groups or with the contralateral control teeth.<sup>[31]</sup> A slight increase in the frequency of surface and inflammatory root resorption resulted after orthodontic movement of teeth with completed root formation.<sup>[33]</sup>

### Vertical occlusal height of the transplanted tooth

Apfel reported that transplanted tooth germs placed in an erupted position did not develop roots,<sup>[8]</sup> while tooth germs transplanted at the original occlusal level at the donor site develop a longer root than teeth placed in a superficial (more occlusal) position.<sup>[36]</sup> Most authors suggest that teeth should be placed in the alveolus at the same occlusal level as that of the donor site. If the donor tooth is fully erupted and has a mature root, it should be placed slightly below the occlusal level, but in patients where the maxillary sinus is low or the mandibular canal is relatively high, it is advisable to place the transplanted tooth more occlusally.<sup>[11]</sup>

### Pulp survival and size of the apical foramen

An important factor for the completion of root growth is pulp survival; 100% of cases of transplanted premolars

with immature roots showed pulpal revascularization.<sup>[37]</sup> However, the likelihood of revascularization and pulpal healing decreases with increasing root maturity. The diameter of the apical foramen of transplanted tooth is a significant factor in pulpal healing. An apical foramen with a diameter greater than 1 mm decreases the risk of pulpal necrosis due to the greater likelihood of revascularization.<sup>[33]</sup>

### Promotion of periodontal healing and avoiding root resorption

The absence of root resorption and the presence of a lamina dura indicate successful periodontal healing, which in most cases is complete within 2 months. Transplanted teeth with mature root development can develop resorption more frequently than teeth with immature roots; it can be detected radiographically within 6 months of transplantation. Inflammatory resorption may be present on periapical radiographs at the 4-week stage and can be stopped by treating the transplanted root with calcium hydroxide. Dentoalveolar ankylosis is one of the major complications in tooth transplantation, and it has been reported that ankylosis occurs because of PDL injury of the donor tooth during extraction or when the root does not fit normally in the socket. In addition, a lack of occlusal stimuli is also considered a factor in ankylosis. To avoid excessive occlusal contact during the PDL healing process, transplanted teeth are often splinted to the adjacent underoccluded teeth. As it has been reported that the competitive regeneration of PDL fibroblasts and osteoblasts in the healing process of periodontal tissue occurs from 4 to 16 weeks after transplantation, the long-term splinting of transplanted teeth may induce dentoalveolar ankylosis [Figure 5].

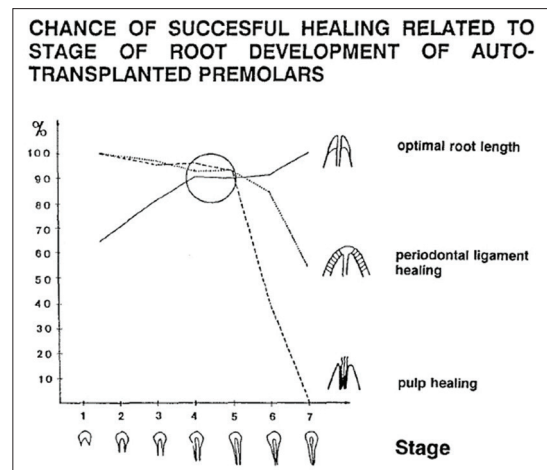


Figure 5: Prediction of optimal root development, pulpal survival, and periodontal healing (i.e., without root resorption) as related to stage of root development at time of transplantation. Graph is based on the results from a long-term study of 370 autotransplanted premolars

Ankylosis can be diagnosed during the first year by radiographic appearance and high metallic percussive sound. Using small rotatory movements with extraction forceps under local anaesthesia, the ankylosed teeth can be luxated and moved successfully to a normal occlusal height. As an alternative, immediate orthodontic extrusion or restorative build-up of the transplant to occlusal height may be attempted [Figure 6].<sup>[33]</sup>

### Orthodontic Alignment of the Transplanted Tooth

In a case report on autotransplantation combined with orthodontic treatment in adult patients, orthodontic forces were applied through the archwire after the splint was removed. The orthodontic treatments in these cases were carried out with 0.018–0.025 inch slot preadjusted edgewise appliances and 0.016–0.022 inch improved super-elastic nickel titanium alloy wires (ISWs; L and H1 Titan; Tomy International Inc., Tokyo, Japan) were used for the alignment. Four weeks after transplantation, the splinting was removed and the alignment of the transplanted teeth began. The ISWs used in those cases have been reported to possess high super-elasticity even when subjected to changing temperatures in the oral environment and have also been reported to have high dumping capacity and shock absorbance. Those properties may have enabled us to not only use stable light orthodontic forces but also preserve the transplanted teeth from the excessive occlusal stimuli.<sup>[9]</sup> In another study, the transplant teeth were given 4 weeks to heal before orthodontic forces were applied, after which rotation, lateral, and axial movement (as needed) were applied with forces from archwires, coils, and elastics.

The average duration of the orthodontic treatment was 21 months.<sup>[38]</sup>

As noted above, it is of vital importance that the transplant be removed without damage to the periodontium.<sup>[39]</sup> However, the horizontal position of the palatally impacted maxillary canine with a crown close to the apices of the incisors sometimes makes atraumatic removal impossible. For such oblique positions, orthodontic pretreatment could move the impacted maxillary canine to a more favorable position and facilitate surgical removal and autotransplantation.<sup>[40]</sup> If the canine is positioned so as to make atraumatic surgical removal impossible or hazardous, orthodontic pretreatment starts with placement of a transpalatal bar soldered onto bands on the permanent first molars. The canine is then surgically exposed and bonded with a button and a silver chain; alternatively, 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 [Figure 2]. In cases where a space needs to be opened for the permanent maxillary canine, this treatment starts about 1 month later with a fixed appliance, once the canine crown has been moved away from close contact with the incisors, thus avoiding the risk of root resorption. After the space opening is completed and the canine has a favorable position for atraumatic removal, the autotransplantation is performed.

### Follow-up

Examination of the available literature regarding prognosis of autogenous dental transplants clearly demonstrates that the rate of success varies with the technique and with the attention given to postoperative care. The excellent efforts of Slagvold and Bjercke, with no failures in 34 transplants, are clear evidence that autogenic transplantation is a legitimate treatment modality.<sup>[11]</sup> Although one tooth showed some postoperative resorption, one appeared to be ankylosed and there was a generalized shortening of ultimate root length, and all their transplants proved to be satisfactorily functioning dental units, which, after all, is the ultimate test of success. As the reorganization of nervous tissue subsequent to transplantation seldom provides a typical sensitivity response, it is not thought that a vitalometer reading should be an indication of success or failure. We prefer that attention be given to the health of the supporting structures. One would expect to see normal color, form, and integrity in the gingival tissues. It should be possible to probe the gingival sulcus at normal depths, and the alveolar bone should be palpable on the labial and lingual surfaces. A normal alveolar bone level should be demonstrable radiographically. There should

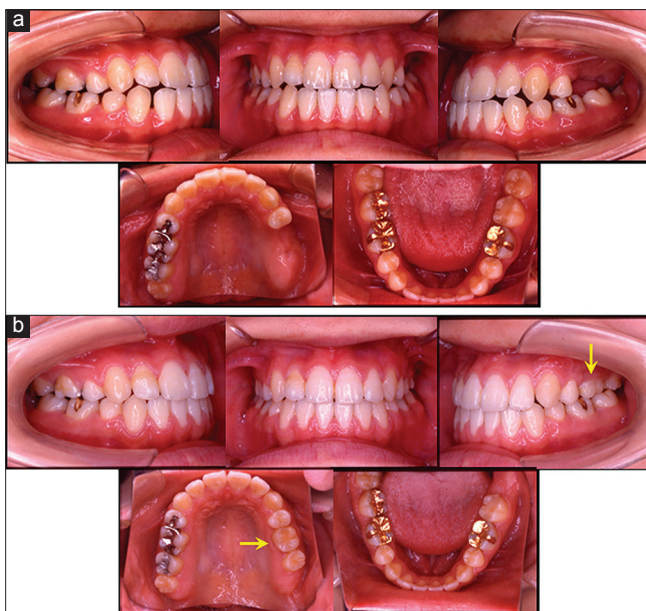


Figure 6: Pre- (a) and posttreatment (b) photographs of case 3 patient; the arrow indicates the transplanted tooth

be a favorable crown-to-root ratio and the potential for further root development. The root shape should not be grossly altered. The periodontal space should be of normal thickness and should completely circumscribe the tooth. While Hale found that apical thickening of the lamina dura may be a sign of impeded root development, it is expected that a normal lamina dura will form on the circumference of a successful transplant.<sup>[13]</sup> Occlusal contacts should not be excessive, and the tooth should maintain a normal eruptive potential. The tooth should not be unusually mobile. Given these clinical signs, the transplant has a good prognosis and should perform like any other tooth in the arch.

## Conclusion

In conventional orthodontics, tooth movement is usually limited to minor distances in the sagittal, vertical, and transverse directions, depending on the technique used. By adding autotransplantation of teeth to the orthodontic armamentarium, a new treatment option becomes available in certain clinical situations, thus making possible moving a tooth to distant or opposite sides of the same dental arch or to the opposite jaw. Transplantation can involve other benefits than tooth replacement, the most important of which is the potential for bone induction and the reestablishment of a normal alveolar process. Even if the transplant later fails, there is an intact recipient area that could be used for an implant. Autotransplantation combined with orthodontic treatment should be considered the first treatment alternative for a missing tooth when a suitable donor tooth is available.

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## Conflicts of interest

There are no conflicts of interest

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