

Mandibular Third Molar Autotransplantation — Literature Review with Clinical Cases

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A b s t r a c t

Autotransplantation of mandibular third molars in a precocious phase of development is indicated when a substitute for adjacent compromised or missing molars is needed, and when mesial movements of the posterior teeth, the resultant loss of space, and overeruption of opposing teeth and consequent changes in the occlusion must be avoided. Provided that the apices of the mandibular third molar are immature, the immediate replacement of a lost or compromised tooth usually ensures a good outcome. Transplantation of third molars helps to maintain alveolar bone and enables endosseous implantation without requiring bone regeneration. We present examples of transplantation of mandibular third molars and review the factors that affect the success or failure of this procedure, such as atraumatic extraction and adequate immobilization of the transplanted tooth and root development after transplantation. Sex or age seem to have no effect on the final outcome.

MeSH Key Words: molar, third; tooth/transplantation; tooth loss/surgery

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Autotransplantation involves the transfer of a tooth from its alveolus to another site in the same person.^{1,2} This site may be either an extraction site or a newly surgically prepared alveolus.^{2,3} Transplantation has a key role in the replacement of young patients' missing teeth.³ Osseointegrated implants are generally contraindicated for young patients with developing alveolar bone because infraocclusion results when the implant fails to form alveolar bone.

Successful tooth transplantation offers improved esthetics, arch form and dentofacial development, mastication, speech and arch integrity. A transplanted third molar also maintains natural space, with little or no root resorption⁴; alveolar bone volume^{3,5}; and the morphology of the alveolar ridge through proprioceptive stimulation.^{3,6}

The outcome of this procedure depends on careful case selection and an understanding of the biological principles.⁵ **Box 1** summarizes the indications for transplantation. Teeth traditionally selected for transplantation are impacted maxillary canines, which play a key role in dentofacial esthetics. A developing mandibular third molar can be transplanted to the socket of a first mandibular molar.^{2,4} Transplantation can also maintain space, for example, in Class I malocclusions for which the space opening is the preferred treatment option, and where a tooth is lost and

good buccal interdigitation exists.³ Transplantation is also indicated for rehabilitation or reconstruction for patients with cleft palate whenever the same teeth are congenitally missing or have an abnormal shape or route of eruption.³

A transplanted tooth diminishes the extent of resorption of newly formed alveolar bone and provides functional stimulation.^{3,9} When Hamamoto and others¹⁰ transplanted teeth into bone-grafted alveolar clefts, they showed that the grafted bone undergoes resorption in the absence of occlusal load. They suggested that this procedure be done soon after the formation of a bone bridge is confirmed so

Box 1 Indications for autotransplantation of teeth^{5,7-9}

- Impacted or ectopic teeth
- Premature tooth loss
- Traumatic tooth loss
- Tumours
- Iatrogenic grounds
- Congenitally missing tooth in one arch with clinical signs of tooth crowding in the opposing arch
- Replacement of developmentally absent teeth
- Teeth with bad prognosis
- Developmental anomalies of teeth and related syndromes



Figure 1a: Initial radiograph for case 1.



Figure 1b: Carious lesion of tooth 47.



Figure 1c: View of tooth 48 still in the alveolus.



Figure 1d: Tooth 48 after extraction. Note the remaining collar of follicular sac.



Figure 1e: Implant of tooth 48 in the prepared receptor alveolus.



Figure 1f: Suture and fixation of the transplanted tooth. Note the remaining follicular sac in the lingual aspect.



Figure 1g: Postoperative situation 2 weeks after the surgery (lateral view).



Figure 1h: Final radiograph, 6 months after the surgery.

that bone remodelling is stimulated as it progresses.

Developmental anomalies of the teeth and related syndromes, such as regional odontodysplasia, tooth aplasia, cleidocranial dysplasia^{3,6} and tooth agenesis,¹¹ are other indications for transplantation.

Patients who have undergone chemotherapy and irradiation have had transplantation, despite doubts about the revascularization of the pulp of an autotransplanted tooth

in irradiated bone since vascularization is assumed to be disturbed.⁸

Clinical Case 1

A 16-year-old healthy female presented with extensive caries in tooth 47, pulpal necrosis and healthy oral soft tissues. Clinical and radiological examinations confirmed the suitability of both the donor and recipient sites (Figs. 1a and 1b).

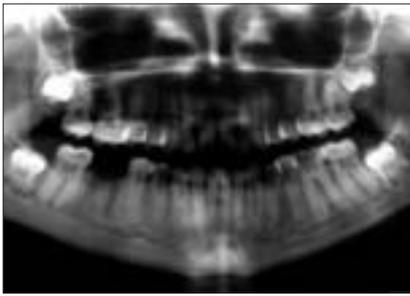


Figure 2a: Initial panoramic radiograph for case 2.



Figure 2b: Initial periapical radiograph.

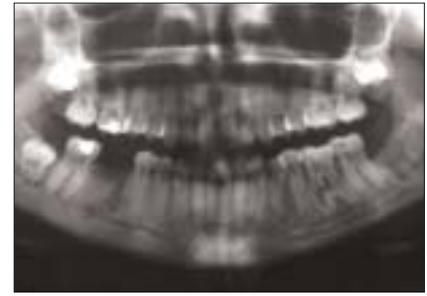


Figure 2c: Final periapical radiograph (1 week after surgery).

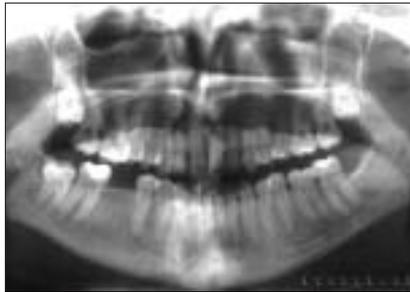


Figure 2d: Final panoramic radiograph.

Although tooth 47 had a pulpal necrosis, no special presurgical preparation was undertaken. The surgical procedure, which is similar to that used for third molar surgery, requires care to avoid injury to the tooth crown and its developing root. Tooth 48 remained in the alveolus until tooth 47 was removed and the socket fully prepared (Fig. 1c). Care was taken to preserve the buccal and lingual alveolar bone during the extraction of 47. The intra-alveolar septum was trimmed with a rongeur, and the socket irrigated. The third molar was stored in gauze soaked in sterile saline, according to the procedure of Raghoobar (Fig. 1d).¹² Tooth 48 was transplanted with the tooth in infraocclusion to provide space for the expected continued root growth and development (Fig. 1e). The surgical wound was sutured, joining the remaining part of the follicular sac to the gingival mucosa.¹³ The interproximal papilla was sutured tightly with a 3/0 silk that passed over the crown of tooth 48 to immobilize it^{13,14} (Fig. 1f). Radiographs were taken 1 week and 6 months later (Figs. 1g and 1h).

Clinical Case 2

A healthy 17-year-old female was referred with extensive caries in tooth 36 and a lingual infraosseous fracture. Clinical examination revealed good oral hygiene. Tooth 38 was in a favourable position and stage of development for autotransplantation. Radiographs (panoramic and periapical) showed favourable development of the third molars (Figs. 2a and 2b).

The surgical procedure was similar to that described for case 1. To spare the circular gingival fibres of tooth 36, no releasing incisions were made. Radiographs were taken at 1 week and 1 year later (Figs. 2c and 2d). The latter revealed complete formation of the root.

Factors That May Interfere with the Success of the Transplant

Autotransplantation of developing third molars has a reported 5-year success rate of about 50%.⁴ Higher success rates have been documented.^{11,14} No large studies reporting success rates for this procedure exist, but case reports indicate that the survival rate for autotransplantation is 10 to 20 years.^{4,7}

The prognosis for an autologous transplant of an unerupted normal tooth is generally good, not only because of the greater probability of total integration in the alveolus, but also due to the lack of any histoincompatibility problem. Some of the factors that may influence the outcome^{4,15} are atraumatic extraction of the transplanted tooth that preserves the root structure; adequate immobilization of the transplanted tooth, which usually requires only a tight suture; and root development after transplantation that allows reestablishment of both innervation and vascularity to the pulp.

Sex or age seem to have no effect on the final outcome.¹⁶ However, because immature teeth are usually covered by a thick follicle or periodontal ligament, which enables extraction of the transplanted tooth with minimal force,⁷ there are fewer chances of damaging the ligament during the procedure. Patients 15 years to 19 years of age are more appropriate candidates for third molar transplants.⁷

Contraindications include cardiac anomalies, poor oral hygiene and poor self-motivation.³ Frenken and others¹ and Thomas and others³ also consider the width of the alveolar process. If the recipient site has insufficient buccopalatal or buccolingual width to accommodate the donor tooth, resorption of the alveolar ridge may occur.³ If transplantation is deferred, it should be scheduled as soon as possible within 2 months so that the resorption of bone that occurs in the interim does not compromise the wound bed for the donor tooth.⁵

Atraumatic Procedure

An atraumatic surgical technique preserves bone and periodontal support.^{3,7,12,16-18} Minimal handling of the transplant is required to protect the Hertwig's root sheath and pulpal tissue³⁻⁵; otherwise root growth may be compromised,³ leading to ankylosis or root resorption and attachment loss.^{12,16} The tooth to be transplanted should be out of its socket a minimal amount of time to avoid desiccation.^{12,16} The longer the tooth is left outside the socket, the poorer the prognosis.^{7,12,16} Vriens and Freihofner⁸ noted that despite damage to the follicle of the upper third molar during surgical transplantation, the clinical outcome is good, even at 5 years' follow-up. According to Tsukiboshi,⁵ the periodontal ligament on the root surface may be repaired by a new attachment mechanism. Its success depends on the space existing between the socket wall of the recipient site and the donor tooth.

The Development of the Root

Transplanted teeth with incomplete root formation have a 96% rate of pulpal healing, compared with 15% for transplanted teeth with complete root formation.¹⁹ Most authors believe that the roots should be developed beyond their bifurcation for successful transplantation of the tooth.⁴ Some authors prefer radiographic evidence that the root has developed at least 2 to 3 mm, whereas others advocate root development of at least 3 to 5 mm.⁴ Still others^{3,4,7,20,21} stipulate root development between one-third to three-quarters of its final length. Although higher success rates are achieved with teeth that have immature roots, these teeth have less root growth after transplantation than other autografted teeth that have more mature, although not completely formed, apices.³ The diameter of the apical foramen is a reliable predictor of pulpal healing. Teeth with an apical diameter greater than 1 mm have a diminished risk of necrosis^{3,5,7,17} because postoperative revascularization is more likely.³ Overall, transplantation of teeth with immature roots offers high success rates because root development of the donor tooth and adjacent alveolar bone growth are unimpeded.^{3,7,11,17}

Autotransplantation is feasible for teeth with complete root development, but endodontic treatment is usually indicated.^{5,7,11} The success rate of autotransplantation of teeth with complete root formation is arguably higher, according to recent data.¹⁷

The American Association of Endodontists recommends that the pulp of teeth with closed apices be extirpated 7 to 14 days after transplantation; otherwise the necrotic pulp and subsequent infection may result in inflammatory resorption and decrease the survival time of the autografts.^{5,7} Moreover, all postoperative treatment should be done within 8 weeks.¹⁷ Endodontic treatment or apicoectomy during the surgical procedure is not advisable because it increases the risk of root resorption.^{3,7}

Adequate Fixation

Excessive time or rigid splinting of the transplanted tooth will adversely affect its healing outcome.^{3,7} Splints can

also compromise oral hygiene procedures, thus leading to periodontal inflammation around the transplanted tooth.⁷ The splint should not force the tooth against the bony walls of the alveolus because it may damage the periodontium.¹⁸ In animal studies,^{3,4,7} splinting did not improve periodontal or pulpal healing after transplantation, but resulted in either increased inflammatory root resorption (ankylosis) of the transplanted teeth or increased pulp necrosis. Most reports advise flexible splinting for 7 to 10 days,^{3,7,18} with sutures placed through the mucosa and over the occlusal surface of the crown^{3,8} because this permits some functional movement of the transplant and stimulates periodontal ligament cellular activity and bone repair.^{3,18}

The transplanted tooth must be placed at the same occlusal level as the donor site so that it will develop a longer root than those placed in a superficial, more occlusal, position.³ However, if the graft has a mature root and is fully erupted, the graft should be placed just slightly below the occlusal level to prevent postoperative trauma.³ The patient should also be advised to eat a soft diet for the first few days after the transplant.

The Transplant Tooth and Periodontal Healing

Preservation of the periodontium of the grafted tooth is key to a successful clinical outcome.^{12,16} When the periodontal fibres are vital, natural reorganization of the periodontal fibres occurs.¹⁶ When the periodontal ligament is damaged, the healing process is characterized by periodontal fibres that run parallel to the root surface.¹⁶ Periodontal healing is usually completed after 8 weeks and appears radiographically as a continuous space around the root^{3,7,17} with absence of root resorption and presence of a lamina dura.^{3,4,10} Conversely, replacement root resorption occurs in teeth with cementum injury, suggesting that cementum is important for the regeneration of the periodontal ligament.¹⁷

Infection at the host site and postoperative control of supragingival plaque adversely influence the success of tooth transplantation.^{7,16} Inflammatory resorption arises through bacterial contamination of either the pulp tissue or the dentinal tubules.¹⁸ Patients should routinely rinse with chlorhexidine gluconate (0.12% in aqueous solution) for several days perioperatively to reduce plaque and promote healing.²² Although some studies^{2,3,7} show no relation between graft survival and administration of antimicrobials, we and other authors^{1,19} believe that antimicrobials improve the patient's chance of having a good clinical outcome.

The final position of the donor tooth within the recipient socket influences periodontal healing. The donor tooth should be placed so that 1 to 2 mm of the width of the periodontal ligament stays above the bone crest to achieve an ideal biologic width.⁵ Otherwise, apical migration of epithelium may occur and result in vertical bone resorption (too deep placement) or long connective tissue attachment (too shallow placement).⁵

Evaluation of Success

Root resorption, marginal periodontal attachment level, mobility and pain affect the success of a transplant.¹⁶ Success is defined as normal periapical healing, without any inflammatory pulpal changes or progressive root resorption, and continued development of root growth.³ Some other factors affect the success of the transplant^{4,5}: the transplanted tooth resides in its new socket without residual inflammation; masticatory function is satisfactory and is without discomfort; the tooth is not mobile; a pathologic condition is not apparent on the radiographs; the lamina dura appears normal on radiographs^{3,4,10}; there is radiographic evidence of further growth of the root; and pocket depths, gingival contour and gingival color are within normal limits.

Complete periapical healing and periodontal health are more reliable parameters of prognosis and success because slight external root resorption (either surface, inflammatory or replacement resorption) is often not radiographically detectable.¹² In fact, replacement resorption (ankylosis) may be evident only 3 to 4 months⁴ to 1 year³ after the procedure, whereas inflammatory resorption may take about 3 to 4 weeks to become evident.^{3,7} Perceiving a metallic percussive sound is, however, an accurate indication that the tooth is ankylosed.^{1,3}

Some authors^{7,11,19} believe that transplanted teeth can be submitted to orthodontic treatment only 3 to 6 months after transplantation. According to Hamamoto and others,¹⁰ orthodontic treatment can be initiated just after regeneration of the periodontal space and subsequent confirmation of the lamina dura on the dental radiographs. The clinician should remember that orthodontic movement of autografted teeth with complete root formation, although possible, results in a slight increase in the frequency of surface and inflammatory root resorption.

Because nervous tissue may take months to grow, unlike vascular tissue that can begin growing within days,⁷ sufficient time, usually up to 1 year, must be allowed to permit reinnervation of the teeth. Teeth with a closed apex can also become revitalized (though rarely).⁷

Avoidance of any kind of trauma is also important for the success of the transplant. Otherwise, trauma will become an extra cause of impaired healing.¹⁶

Conclusion

In growing persons, bridgework and implants are not feasible because they may impede the normal growth of facial bones, in particular, of the alveolar process, and are therefore contraindicated.^{7,11} Therefore, when space closure seems an unlikely or undesirable option, the transplant of a tooth with incomplete root formation may be an alternative solution because both alveolar growth and root development will be unimpeded.^{7,11} Although the patient's age is not a factor for successful autoplasmic transplantation, available epidemiologic data^{3,4,7,11,17,19} indicate that better results can be achieved when it is done at a younger age, when the donor tooth is still developing so that its eruptive

Box 2 Advantages and disadvantages of transplantation

Advantages

Better alternative than fixed or removable prosthodontics
Avoidance of adjacent teeth preparation
Comparative cost-effectiveness

Disadvantages

Surgical involvement superior to that of a simple extraction
Poor prediction of the final outcome
Eventual loss of the tooth because of possible complications such as root resorption and loss of attachment

potential can be used to best advantage.

In case 1, the existence of a necrotic lesion of the pulp was not a contraindication for the procedure because there was no terminal periodontal disease nor an acute inflammatory process.^{4,7} Whenever unrestorable teeth need to be extracted, clinicians should make patients aware of other treatment alternatives, such as tooth transplantation, rather than replacing teeth with a fixed or removable prosthesis, and the advantages and disadvantages of transplantation, as depicted in **Box 2**, should be taken into consideration.⁵ ➤



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