

## Autotransplantation of teeth: A Review

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### ABSTRACT

Autotransplantation provides the possibility of a natural tooth rather than a prosthesis or an osseointegrated implant to replace a missing tooth. The indications for autotransplantation are wide, but careful patient selection coupled with an appropriate technique is a prerequisite for a good functional and esthetic outcome. This article discusses about the indications for autogenous tooth transplantation, the biological principles required for success, the recommended surgical technique, factors affecting the success, as well as the success rate.

**Keywords** :Autotransplantation, missing teeth, ankylosis.

### INTRODUCTION

Autotransplantation refers to the repositioning of autogenous erupted, semierupted or unerupted tooth; from one site into another in the same individual.<sup>1</sup>The earliest reports of tooth transplantation involve slaves in ancient Egypt who were forced to give their teeth to their pharaohs. Autogenic transplantation of teeth was described for the first time in the dental literature by the Swedish dental surgeon Vidman in 1915.<sup>2</sup>Transplantation offers potential benefits such as bone induction and the reestablishment of a normal alveolar process in addition to tooth replacement. Even if the transplant fails later, there is an intact recipient area that could be used for an implant. A prerequisite for this method, however, is a thorough knowledge of the factors that influence the long-term success rate. If done properly, this method may supplement and/or can be used as a viable treatment option in present day clinical practice.

**Biological Principles and their Clinical Applications:** The type of healing of transplanted tooth is dependent on the surface area of the damaged root to be repopulated. When the damaged PDL surface is small, the healing can be achieved by cemental healing. However when the damaged PDL surface is large, some of the root surface will be

resorbed followed by apposition of bone rather than dentine, thus root resorption will ensure. Genetically, PDL cells can differentiate into fibroblasts, cementoblasts and osteoblasts. In an ideal situation, one would hope PDL cells on the root surface to differentiate into cementoblasts and induce dentine formation, whereas PDL cells on the side of bony socket wall surface to differentiate into osteoblasts thus inducing bone formation. In addition, the contributions of the progenitors PDL cells on the recipient fresh extraction sockets also accounts for the higher success rate for freshly extracted recipient sockets compared to artificially drilled ones. It is important to minimize inflammation so that reattachment can progress to the healing stage with the proper differentiation of the PDL cells. Inflammation will be minimized when the transplanted tooth is sealed with tight suturing of the gingival cuff around the tooth to prevent ingress of infective agents. This can be achieved by trimming and suturing of the recipient site flap before the implantation of the donor tooth. It is also important to minimize inflammatory pulpal response from the transplanted tooth. For fully developed donor teeth, root canal treatment should be initiated 2 weeks after transplantation. The interim period of 2 weeks is chosen to minimize trauma to the PDL in the initial

reattachment healing phase, yet further delay will increase the chance of complication of inflammatory resorption secondary to pulpal infection. In the case of donor tooth with incomplete root formation, the preservation of the apical Hertwig's epithelial sheath is important to ensure pulpal regeneration and root maturation and eruption. Ideally, one would prefer the donor tooth to be at its maximum length but still has its potential for pulp regeneration with apex opening >1mm radiographically.

**Indications for autotransplantation of teeth:** Impacted or ectopic teeth: Autotransplantation may provide a simplified and faster treatment option for patients with ectopically positioned teeth. In cases of severe ectopic position of maxillary canines, transplantation can be considered as a treatment alternative.<sup>3</sup>

Traumatic tooth loss: Maxillary incisors are the teeth most frequently involved in trauma. Zachrisson reported autotransplantation of the developing mandibular second premolar to the avulsed maxillary incisors.<sup>4</sup>

Tumours: autotransplantation shows benefit in selected cases of jaw reconstruction, with distal bone autotransplants as alternative to dental titanium implants and supra structures.<sup>5</sup>

Congenitally missing tooth in one arch with clinical signs of tooth crowding in the opposing arch: If extraction has been planned in the maxilla for the correction of crowding or reduction of an overjet, a maxillary premolar may be transplanted to the second premolar site in the mandible.<sup>6</sup>

Teeth with bad prognosis: In most cases, the tooth or teeth to be extracted due to caries or periodontal disease are the first molars. In this case, transplantation of third molars to the first molar site may be considered.<sup>7</sup>

Developmental anomalies of teeth and related syndromes: Developmental anomalies of the teeth and related syndromes, such as regional odontodysplasia, tooth aplasia, cleidocranial dysplasia<sup>8</sup> and tooth agenesis<sup>9</sup> are indications for transplantation.

**Contraindications:** include cardiac anomalies, poor oral hygiene poor self-motivation and insufficient width of the alveolar bone. If the recipient site has insufficient buccopalatal or buccolingual width to accommodate the donor tooth, resorption of the alveolar ridge may occur.<sup>8</sup> 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.<sup>2</sup>

**Technique:** The sequence of autotransplantation of teeth includes: clinical and radiographic examination, diagnosis, treatment planning, surgical procedure, endodontic treatment, orthodontic treatment, restorative treatment, and follows up.

**Examination and diagnosis:** Anatomic shapes of the donor teeth and recipient sites, stage of root development, ease of preparation of the recipient socket and potential for damage of the donor tooth at removal are evaluated clinically and radiographically.

**Treatment planning:** Timing of tooth extraction at the recipient site is carefully determined. If the tooth is extracted prior to the date of transplantation, transplantation should be performed within 2–6 weeks after the extraction because extensive bone resorption will occur after 6 weeks. Immediate transplantation with an extraction at the recipient site will be preferable if enough gingival tissue to close around the donor tooth is expected. If root-canal treatment is deemed inevitable based on the stage of root development of the donor tooth, it may be completed before transplantation or initiated 2 weeks after transplantation. Restorative treatment of transplants should be discussed to avoid unnecessary tooth reduction. More esthetic results will be achieved by restoring transplants with composite rather than by fabricating artificial full-coverage prosthetics.

**Surgical procedure:** It is recommended to administer antibiotics a few hours before surgery. In immediate transplantation, the tooth to be extracted in the recipient site should be extracted before the donor tooth. The donor tooth should be examined for anatomical form, size and PDL condition. Care must be taken not to damage the PDL. An intra-crevicular incision is made before luxation to preserve as much PDL on the root as possible and the donor is extracted slowly and as atraumatically as possible. The donor tooth should be placed back in its original socket after it is removed. If any extra-oral time is anticipated, the tooth should be stored in a storage medium like Hank's balanced salt solution that will maintain the viability of the periodontal ligament cells. The mesio-distal width of the root and crown and the length of the root of the donor are measured. The recipient socket is prepared a little larger than the donor using surgical round bars at low speed and cooling with saline. The match between the recipient

and the donor is periodically checked by attempting to place the tooth into the socket with light pressure. Obstacles in the socket wall are removed as encountered. The optimal placement of the donor to the recipient is to establish the biologic width similar to that of a naturally erupted tooth. Deep placement to a position below the occlusal level of adjacent teeth should be avoided, if possible, so that orthodontic treatment will not be needed at a later stage. Tight closure of the gingival flap around the donor tooth is most important. This optimizes reattachment and may block bacterial invasion into the blood clot between the tooth and socket. In order to achieve this close adaptation around the donor tooth, trimming of flap is needed in some cases, and suturing of flap before the donor is positioned into the socket is recommended in every case. Tighter and closer adaptation between the flap and the donor tooth will be achieved by suturing before the donor positioning than after it. The donor tooth is placed lightly into the recipient socket through the opening of the sutured gingival flap. Ideally, the gingival opening should be a little narrower than the donor diameter because a tight adaptation between the tooth and gingiva is desirable. Splinting by means of sutures is then performed. If the transplant is not stable after suture splinting or if much more occlusal adjustment is necessary, splinting is changed to one with wire and adhesive resin. If the transplant is not stable but no occlusal adjustment is needed, splinting with wire and resin can be delayed for 2 or 3 days after suture splinting because the former is time consuming and bleeding during the surgical procedure makes optimal results difficult.

**Occlusal adjustment:** The occlusion must be checked to ensure that no occlusal interference is present. If a suture is used for stabilization, ideally the occlusal contact should be reduced extra-orally prior to positioning of the donor, taking care not to damage the PDL. It could also be performed intraorally before the extraction of the donor. If a wire splint is used, occlusal adjustment can be done after placing the splint. Occlusal adjustment should be conservative, since a composite restoration will be needed after healing to adjust the occlusion and/or esthetic appearance of the crown of the tooth. A radiograph is taken preoperatively, before and after splinting to evaluate the position of the donor tooth in the new socket. Surgical dressing (periodontal packing) is applied to protect the transplant against infection during the first 2–3 days in the wound healing. This dressing is removed at about 3–4 days post-surgery. The sutures are removed 4–5 days after the surgery.

**Root-canal treatment:** Pulp healing can be expected in the transplantation of developing teeth. In such a case, a radiograph is taken every month for 3 months after the surgery to monitor inflammatory resorption or apical periodontitis due to pulp space infection. If any sign of pulp infection is observed, root-canal treatment should be initiated as soon as possible.<sup>10</sup> If no sign of pulp infection is seen, a radiograph is taken 6 months after the surgery to evaluate continued root development and pulp canal closure. When regeneration is successful, pulp canal obliteration is inevitable and should be considered a positive sign of pulp health.<sup>11</sup> Sensitivity tests should become positive at this 6-month recall. On the other hand, the pulp in fully developed transplants cannot regenerate. This does not disqualify these teeth from transplantation. Root-canal treatment should be planned at the appropriate time. If the donor tooth is accessible, the endodontic treatment can be completed before surgery. If the donor is impacted or erupted in a position that makes endodontic access difficult, the root-canal treatment should be started 2 weeks after transplantation. The 2-week timing for endodontic treatment is extremely important, since endodontic treatment performed too soon after surgery may cause additional PDL damage and if it is delayed past 2 weeks, inflammatory resorption may develop due to infection in the root-canal system.

**Orthodontic treatment:** if necessary, can be initiated 1 month after transplantation with mature teeth.

**Restorative treatment:** In an ideal situation, when a developing third molar is transplanted to another site in the arch, restorative treatment is not necessary, provided pulp healing occurs. In less ideal situations, restoration of crown is needed, such as filling an access cavity for root-canal treatment, creating improved interproximal contact, or recontouring the crown for occlusion and esthetic.

The patient should also be advised to eat a soft diet for the first few days after the transplant. Chlorhexidine rinse and antibiotics should be prescribed for a week after the surgery.

#### **Factors affecting success:**

**Atraumatic Procedure:** An atraumatic surgical technique preserves bone and periodontal support. Minimal handling of the transplant is required to protect the Hertwig's root sheath and pulpal tissue; otherwise root growth may be compromised, leading to ankylosis or root resorption and attachment loss.<sup>8</sup> The tooth to be transplanted should be out of its

socket a minimal amount of time to avoid desiccation. The longer the tooth is left outside the socket, the poorer the prognosis.<sup>12</sup> A 5 year follow up study by Vrien showed that despite damage to the follicle of the upper third molar during surgical transplantation shows a good result.<sup>13</sup>

**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.<sup>10</sup> Most authors believe that the roots should be developed beyond their bifurcation for successful transplantation of the tooth. 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.<sup>14</sup> Still others stipulate root development between one-third to three-quarters of its final length.<sup>8</sup> 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.<sup>8</sup> 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 because postoperative revascularization is more likely. 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.<sup>15</sup> The success rate of autotransplantation of teeth with complete root formation is questionable. 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.<sup>2</sup> Moreover, all postoperative treatment should be done within 8 weeks.<sup>16</sup> Endodontic treatment or apicoectomy during the surgical procedure is not advisable because it increases the risk of root resorption.<sup>8</sup>

**Adequate Fixation:** Excessive time or rigid splinting of the transplanted tooth will adversely affect its healing outcome. The splint should not force the tooth against the bony walls of the alveolus because it may damage the periodontium.<sup>16</sup> Most reports advise flexible splinting for 7 to 10 days, with sutures placed through the mucosa and over the occlusal surface of the crown because this permits some functional movement of the transplant and stimulates periodontal ligament cellular activity and bone repair.

Splints can also compromise oral hygiene procedures, thus leading to periodontal inflammation around the transplanted tooth. 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. 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.<sup>8</sup>

**Periodontal Healing:** Preservation of the periodontium of the grafted tooth is key to a successful clinical outcome. When the periodontal fibers are vital, natural reorganization of the periodontal fibers occurs. Periodontal healing is usually completed after 7-8 weeks and can be diagnosed radiographically as a continuous space around the root with absence of root resorption and presence of a lamina dura. 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. Apical migration of epithelium may occur and result in vertical bone resorption due to deep placement or long connective tissue attachment due to too shallow placement.<sup>2</sup>

Infection at the host site and postoperative control of supragingival plaque: adversely influence the success of tooth transplantation. Bacterial contamination of either the pulp tissue or the dentinal tubules can lead to inflammatory resorption.<sup>17</sup> Patients should routinely rinse with chlorhexidine gluconate (0.12% in aqueous solution) for several days perioperatively to reduce plaque and promote healing.<sup>15</sup> Although some studies show no relation between graft survival and administration of antimicrobials,<sup>18</sup> few authors believe that antimicrobials improve the patient's chance of having a good clinical outcome.<sup>10, 19</sup>

**Evaluation of success:** Success is defined as normal periapical healing, without any inflammatory pulpal changes or progressive root resorption, and continued development of root growth. 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 detected radiographically, perceiving a metallic percussive sound is an accurate indication that the tooth is ankylosed.<sup>19</sup>

**Success:** Success rates are found to be 90% or higher. In a recent study, Sugai followed 114 transplants and found a one-year success rate of 96%, with 84% at five years.<sup>20</sup> Other studies have shown between 79 and 95% success rates, with follow-up times as long as 41 years.<sup>21</sup> Another recent study, by Bae, showed that high success rates (84%) can even be achieved with closed apex teeth and root canal treatment.<sup>22</sup> These consistently high success rates are a contrast to the variable results reported in many older studies. Schwartz and others<sup>16</sup> yielded success rates of only 76.2% at 5 years and 59.6% at 10 years.<sup>23</sup> Similarly, Pogre found that his success rate for 416 auto transplanted teeth was 72%.<sup>24</sup>

**Advantages:**

- Better alternative than fixed or removable prosthodontics since it avoids adjacent teeth preparation.
- Biological & economical treatment alternative for tooth replacement.
- autotransplantation may also be considered as a temporary measure in young patients. The transplant can replace missing teeth to ensure preservation of bone until growth has ceased for implants.

**Disadvantage:** more technique sensitive and less predictable in terms of success rate & aesthetic outcome.

**DISCUSSION:**

The science of autotransplantation has progressed, as evidenced by the high success rates reported in studies over the past decade. Successful tooth transplantation offers improved esthetics, arch form, dentofacial development, mastication, speech and arch integrity. A transplanted third molar also maintains natural space, with little or no root resorption,<sup>14</sup> alveolar bone volume, and the morphology of the alveolar ridge through proprioceptive stimulation.<sup>2</sup> The outcome of ATT depends on wise case selection and consideration of all biological aspects. A prerequisite for this method, however, is a thorough knowledge of the factors that influence the long-term success rate. Preservation of the periodontium of the grafted tooth is the key to a successful clinical outcome. Autotransplantation possesses many distinct advantages over fixed prosthesis or implants in terms of function, cost, time, esthetics, and ease with which complications can be managed.<sup>9</sup> The science of autotransplantation has progressed, as evidenced by the high success rates

reported in studies over the past decade, these studies demonstrate that autotransplantation is a viable option for tooth replacement for carefully selected patients.<sup>14</sup>

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