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# Autotransplantation of Tooth in Children with Mixed Dentition

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## Abstract

Autotransplantation of tooth in children is the surgical movement of a tooth from one place in the mouth to another in the similar individual. Once thought to be uncertain, autotransplantation has achieved high success rates and is an outstanding option for tooth replacement in children. Although the indications for autotransplantation are narrow, careful patient assortment coupled with a suitable method can lead to exceptional esthetic and useful results. One benefit of this procedure is that placement of an implant-supported prosthesis or other form of prosthetic tooth replacement is not needed. A review of the recommended surgical technique as well as success rates is also discussed.

**Keywords:** Auto transplantation; Clinical indications; Healing factors; Cryopreservation

## Introduction

The age at which the first tooth appears differs very much from child to child. Very occasionally, children are born with one or more teeth. These may need to be removed if they are very loose, as there is a risk that the child could swallow them, or have difficulties with breastfeeding. Other children may not expand any teeth until they are more than a year old. Usually, the first tooth; which tends to be in the middle of the lower jaw, appears at around six months of age. The complete set of 20 primary teeth (baby teeth) is usually present by the age of two and a half years. The first permanent teeth appear at around six years of age. These tend to be the incisors in the middle of the lower jaw and the first permanent molar teeth. The molars come up behind the primary teeth; they do not replace them [1-3].

As there are a lot of reasons for autotransplanting teeth in children, tooth defeat as a result of dental caries is the most common sign, particularly when mandibular first molars are concerned. First molars erupt early and are often a lot restored. Autotransplantation in this situation involves the removal of a third molar which may then be transferred to the site of an unrestorable first molar. Extra circumstances in which transplantation can be careful include tooth agenesis (particularly of premolars and lateral incisors), shocking tooth loss, atopic outbreak of canines, root resorption, large endodontic lesions, cervical root fractures, localized juvenile periodontitis as well as other pathologies. Successful transplantation depends on specific requirements of the patient, the donor tooth, and the recipient site [3].

Patient selection is very significant for the achievement of autotransplantation. Child must be in good health, able to follow postoperative instructions, and available for follow-up visits. They should also demonstrate a satisfactory level of oral hygiene and be agreeable to regular dental care. Most importantly, the child must have a suitable receiver site and donor tooth. Patient collaboration and comprehension are extremely important to ensure predictable result [4].

The most significant criteria for success connecting the recipient site are adequacy of bone support. There must be enough alveolar bone support in all dimensions with sufficient attached keratinized tissue to allow for stabilization of the transplanted tooth. In addition, the recipient site should be free from acute disease and chronic irritation. The donor tooth should be positioned such that extraction will be as a traumatic as possible. Irregular root morphology, which makes tooth removal very difficult and may involve tooth sectioning, is contraindicated for this surgery. Teeth with also open or closed apices may be donors; however, the most unsurprising results are obtained with teeth having between one-half to two-thirds finished root development. Surgical treatment of teeth with less than one-half root formation may be too shocking and could compromise further root development, stunting maturation or changing morphology. When root development is better than two-thirds, the increased length may cause infringement on vital structures such as the maxillary sinus or the lesser alveolar nerve. Also, a tooth with total or near complete root configuration will usually require root canal therapy, while a tooth with an open apex will remain vital and should carry on root development after transplantation. In the latter case, successful transplantation without the need for further endodontic therapy is usually seen.

The mixed dentition is the developmental period after the permanent first molars and incisors have erupted, and before the remaining deciduous teeth are lost. Treatment is usually done early in this period. The American Association of Orthodontists recommends all children should see an orthodontist by age 7. A favorably developing occlusion at this stage has these characteristics [2,5].

### Mixed dentition

In a longitudinal study, Moorrees and Reed [6] found that arch length decreases 2 to 3 mm between the ages of 10 and 14 years, when primary molars are replaced by permanent premolars. These authors also found a reduction in arch circumference of approximately 3.5 mm in the mandible in boys and 4.5 mm in girls during the mixed-dentition period. If crowding is evident in the early mixed-dentition years, it will not improve with further growth and development [7-9].

### Mesial shift

In patients with a spaced primary dentition and a flush or straight terminal plane, the flare-up of the permanent mandibular first molars at approximately 6 years of age closes the space distal to the primary canines (primate space) and transforms the molar relationship into a Class I relationship. This has been referred to as “early mesial shift”

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[10]. In patients with a closed primary dentition (no primate space) and a straight terminal plane, the transformation into a Class I molar relationship may not occur until the exfoliation of the primary molars. At approximately 11 years of age, the permanent first molars migrate forward to close up the excess leeway space provided by the difference in size between the primary molars and the succedaneous premolars. This has been called "late mesial shift" [10]. The transformation into a Class I molar relationship depends on a number of dental and facial skeletal changes, both genetic and environmental, that interact to achieve (or not achieve) a normal occlusion. Several factors may prevent the establishment of a normal posterior occlusion. Extensive interproximal caries or ectopic eruption of the maxillary first molars may result in premature loss of primary second molars and a subsequent loss of arch length. Periapical pathology of primary teeth may hasten the eruption of their permanent successors. Tumors and supernumerary teeth may impede the course of eruption. Prolonged retention of primary teeth may disturb the eruption sequence.

### Leeway space

The difference in size between the primary molars and the succedaneous premolars is termed "leeway space" This varies greatly from person to person, according to a longitudinal study by Teixeira et al. [11] the average leeway space in that study was 2.2 mm in the maxilla and 4.8 mm in the mandible. The differences in the leeway spaces between the maxillary and mandibular arches were 1.3 mm for male subjects and 1.1 mm for female subjects. The range in the amount of leeway space between people is quite remarkable and can exceed the above amounts [11-13].

### Incisor liability

The size differential between the primary and permanent incisors is called "incisor liability". In the anterior segment, the four permanent maxillary incisor teeth are, on average, 7.6 mm larger than the primary incisors. In the mandibular arch, the permanent incisors are 6.0 mm larger than the corresponding primary teeth [14]. Incisor liability varies greatly from person to person. The spacing of the primary anterior teeth; lateral and even possibly distal shifting of the primary canines; and facial positioning of the incisors all contribute to the incisor liability. All of these factors will increase the arch perimeter and help the mouth accommodate the larger permanent teeth.

### Eruption sequence

In a study by Díaz et al. [15] the most favorable sequence of eruption to obtain a normal molar relationship was as follows: first molar, central incisor, lateral incisor, first premolar, second premolar, canine, second molar in the maxilla and first molar, central incisor, lateral incisor, canine, first premolar, second premolar, second molar in the mandible. The most unfavorable sequence in the maxilla was that in which second molar erupted earlier than either the premolars. The most unfavorable sequence in the mandible was that in which the canines erupted later than the premolars (Table 1).

| Radiographic examination | Clinical examination | Histological examination |
|---|---|---|
| • No evidence of progressive inflammatory root resorption<br>• Normal PDL space width around the transplanted tooth<br>• No disturbance in root development<br>• Lamina dura<br>• Healing of alveolar bone | • Normal tooth mobility and normal tooth function<br>• Gingival healing and no indication of marginal attachment loss, inflammation<br>• Healing of dental pulp<br>• No patient discomfort<br>• Normal percussion sound | • The PDL fibers are aligned to perpendicular, not parallel, to the root and alveolar bone<br>• However, without extraction, it is impossible to evaluate clinical cases histologically |

**Table 1:** Criteria for success in autotransplantation.

## Treatment Strategies

Mixed dentition treatment goals often focus on skeletal rather than dental correction. To design a treatment plan, the clinician must understand the growth and development patterns, and the known effects of the chosen treatment modality

Many dental development problems can be headed off in the mixed dentition; for example, anterior cross bites. In-time removal of a deciduous tooth could prevent a cross bite, but once the permanent upper incisor is caught on the lingual of the lower incisors, treatment is needed. The anterior cross bite can cause tissue damage around the affected lower incisor. Another example is the displaced lower midline as a result of the early loss of a lower deciduous canine [6,7].

## Autotransplantation

This is a surgical procedure in which tooth from one part of the mouth is transplanted to another. Indications for such procedure are as below:

1. Hypodontia- This is where there are missing tooth or teeth such as a missing central incisor, a premolar can be use as a substitute;

2. Premature loss of tooth- Especially true in first molar area where it may have been loss due to caries and the space is too great to be closed by the second molar. A third molar tooth is judiciously removed and a socket is prepared in the first molar area and molar is then placed and secured with 0.5 mm eyelet wire to the adjacent teeth.

There are a lot of dental procedures being utilized by consumers whether for aesthetic purposes or medical, and tooth transplantation is the most common one. Basically, this is done by moving a tooth from a site to another site of the mouth and rarely to another recipient. Studies showed that implants utilized in filling gaps of missing front teeth are not the best alternative since this can cause a considerable amount of bone loss and abrasion on neighboring teeth and surrounding gums. Autotransplantation is considered a better alternative in certain cases. [1,4,8,9]. Autotransplantation is a tooth surgical procedure in one location to another location within the same person. Before, this was considered experimental, but in present times, autotransplantation is a better alternative for tooth replacement with high success rate. Indication for clients opting for this procedure is narrow (Table 2), and thorough patient selection added with appropriate technique leads to outstanding aesthetic and functional capabilities. One advantage of this procedure is that the placement of implant-supported prosthesis or other form of prosthetic tooth replacement is not essentially required [10,11].

## Indications for Autotransplantation

Usually, autotransplantation is done because of tooth loss due to dental caries, predominantly in the first molars of the lower jaws. Early eruption of first molars is frequently restored. In this case, the third molar is then removed via autotransplantation and then transferred to the site of the first molar that is beyond saving. Transplantation can also be opted in cases like tooth agenesis (premolars and lateral incisors), traumatic tooth loss, canine atopic eruption, root resorption (body of the cells attack and destroy a part of a tooth), large endodontic lesions, cervical root fractures, and localized juvenile periodontitis [3,7,8,10,11].

Transplant success depends primarily on the specified requirements from the client, donor tooth, and recipient site. Autotransplantation success is based on how well the healing takes place after the procedure [8]. A healthy tooth with undamaged periodontal ligament will have higher degree of success. Before having this procedure, clients must have a good health and oral hygiene regimen. Most of all, a suitable donor tooth and recipient site are required so that tooth can be replanted appropriately. The site should be well prepared in receiving the tooth donor. Size should accommodate a tooth, along with sufficient alveolar bone structure, which enables support. This should be free from inflammation and infection. The replanted donor Tooth (the tooth) should be positioned to assist in easy removal with minimum trauma possible. Misshapen teeth or abnormal root morphology are not used in transplants [9-12].

Tooth length and development stage is vital in determining the affectivity of a replantation wherein the tooth has between one-half to two-thirds complete root development. So, autotransplantation of the premolars where there is half to two thirds completed root development have higher chances of pulp survival, with minimum chances of necrosis (cell death).

Another factor influencing tooth development is the status of epithelial root sheath or the covering. HERS or Hertwig's epithelial root sheath has a continuous production of cells that separates a pulp to a dental follicle. HERS determines the root growth by its degree of damage so the lesser the damage, the greater chance of root growth post transplantation [2,8,10,11,13].

## Tooth Cryopreservation

Teeth autotransplantation with cryopreservation is an alternative currently utilized for clients in a few clinics. With cryobiology, cells or whole tissues are preserved by cooling it to sub-zero temperature at around 77K or -196°C (boiling point of liquid nitrogen). Low temperatures leads to prevention of cell death (necrosis) and ceasing of biological activities along with its biochemical reactions. Experiments on mice showed effectively of cryopreservation on the teeth, resulting to dental tissue survival even at below freezing point.

Teeth cryopreservation requires a wider understanding of cryoprotective mechanisms of co solvents like dimethyl sulfoxide (DMSO). Consequently, only a few clinics have the expertise to do tooth cryopreservation and make it available to their clients. With cryopreservation, elevated numbers of healthy teeth extractions can be done for orthodontic purposes and it enables sufficient amounts of donor teeth in cases of extensive surgical reconstruction. Tissue banks for teeth tissues are regulated legally for quality control [7,9,10,11,13].

## Surgical Technique for Tooth Transplantation

The same amount of trauma is experienced by the patients having a removal of impacted molars to that that underwent tooth transplantation. Sedation along with local anesthesia is utilized in this case. Once the effect of anesthesia is sufficient, then extraction of the tooth at the recipient site and recipient socket is prepared. Replantation of an acrylic replica of a tooth is done after an X-ray and donor tooth scan. This replica will guide the tooth technician to prepare a donor site for its dimension, etc., (Table 1). Then, extraction of the donor tooth should have least damage on the periodontal ligament and positioned quickly on the recipient site. Instructions and follow-ups given to post operative clients are similar in that of removal of tooth impaction [4,7,8,14-17]. A soft diet is followed for several days post-surgery, and chewing on the transplant should be avoided. Clients should always maintain good oral hygiene.

| Patient related factors | Donor tooth related factors | Recipient site related factors | Clinical factors |
|---|---|---|---|
| • Better results in younger patients<br>• A patient free of major systemic and metabolic problems or specific habits (e.g., smoking)<br>• Good oral hygiene and a cooperative attitude. | **1. Periodontal ligament (PDL)**<br>• The presence of intact and vital PDL attached to the root surface<br>• Preservation of vital PDL when the tooth is outside the mouth using physiologic salt water or milk or preservation liquids and as short a surgery time as possible<br>• Enhanced healing of the gingival tissue by placing a 1 mm band of PDL fibers on the root above the crest of bone<br>• A major factor in the formation of alveolar bone<br>• A chance of inadequate PDL development as an effective attachment with an impacted tooth (nonfunctioning tooth)<br>**2. Healing of dental pulp**<br>• The preservation of Hertwig's epithelial root sheath (HERS)<br>• Healing of the dental pulp occurs until Moorrees tooth development stage 5<br>• When the diameter of the apical foramina is >1 mm, there is more than an 87% chance the dental pulp will heal<br>**3. Continuation of root development**<br>• Ideal timing of transplantation is when development of the donor tooth roots is 3/4 to 4/5 complete<br>**4. Gingival adaptation**<br>• Tight flap adaptation prevents bacterial invasion into the recipient socket<br>**5. Root morphology**<br>• Teeth with a single, cone-shaped root without concavity around the cervical area are most favorable. | • Bone width and height should be adequate to receive the donor tooth<br>• Better healing can be expected if the PDL tissue is still attached<br>• Transplantation should be performed the day of transplantation or within 1 month after extraction | Surgery should be performed by a clinician with experience in such areas as Surgery should be performed by a clinician with experience in such areas as donor tooth extraction, preparation of the recipient site, and tissue management |

**Table 2:** Successful healing factors associated with autotransplantation of teeth.

## Auto Transplantation: Surgical Technique

The surgical techniques used in autotransplantation have progressively been modeled and refined over the years. Good

| Patient age | Function and esthetics | Orthodontic movement | Gingiva | Time and cost | Long-term results |
|---|---|---|---|---|---|
| • No patient age limit. However, patients older than 40 have a better success rate when implant treatment have been used. | • Has a normal PDL, serving as a shock absorber and a proprioceptor<br>• Can promote bone formation<br>• Normal eruption is possible<br>• In some cases, prosthetic treatment is not required<br>• Adjustable position after surgery<br>• Needs an ideal donor tooth | • Can be moved orthodontically | A normal gingival contour can be induced | • Needs fixation stage<br>• Less costly | Transplanted teeth have been observed for up to 40 years and have similar healing rates |

**Table 3:** Factors in the choice of dental autotransplantation.

oral hygiene, self-motivation and a medical history that does not contraindicate transplantation (e.g. cardiac defects) are prerequisites before this avenue of treatment is embarked upon. Andreasen et al. [1] carried out a long-term study of 370 autotransplanted premolar teeth to determine a standardized surgical procedure which optimized pulpal and periodontal healing [16-18]. Although there is published variations for the surgical technique of autotransplantation, the consistent message is one of a careful a traumatic surgical technique to maximally preserve an intact periodontal ligament. If Hertwig's root sheath is traumatized, then future root growth is limited or inhibited, according to the severity of this trauma (Table 2). Evidence based transplantation techniques are combined in a 'protocol for transplantation' included at the end of this paper [2,13,14,18].

In some cases autotransplantation may not be possible as a one stage procedure. Two stage transplantation has been reported in which an ectopic canine was removed and initially stored in the buccal pouch whilst the recipient site was orthodontically reopened (Table 3). The potential problem of resorption of the transplanted tooth is minimized if contact between the tooth and periosteum is avoided during storage. In some situations, there may be resorption of the alveolar ridge at the recipient site with insufficient bucco-palatal width to accommodate the transplant. In such cases, specialized investigative techniques (e.g. Scanora, CT tomography) may need to be carried out to ascertain the amount of bone present as bucco-palatal. Alveolar bone grafting of the recipient site may be required prior to transplantation [4,11,14,17-20].

## Conclusion

Although autotransplantation in children has not been established as a traditional means of replacing a missing tooth, the process warrants more reflection. New studies obviously show that autotransplantation of teeth in children is as successful as end osseous dental implant placement. Minimum acceptable success rates for end osseous titanium dental implants are 85% after 2 years and 80% after 5 years. For children, autotransplantation may also be considered as a provisional measure. The transplant can replace missing teeth to make sure preservation of bone until growth has ceased and then, if essential, the patient can become a candidate for implants. With suitable patient selection, and presence of a suitable donor tooth and recipient site, autotransplantation should be considered as a viable option for treatment of an edentulous space.

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