CASE REPORT

Treatment of an avulsed maxillary permanent central incisor replaced by autotransplantation of a mandibular premolar: 14-year follow-up

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Abstract


Aim To present the 14 year follow-up of a case in which an avulsed permanent maxillary central incisor was replaced by autotransplantation of a mandibular premolar.

Summary A mandibular premolar (Moorees’ stage 3) was transplanted into the space left by an avulsed permanent maxillary central incisor after a delay of 3 months. Recall examination 14 years after transplantation revealed a normal periodontal architecture with absence of infection, ankylosis or progressive resorption. The transplantation of a premolar is seen as a promising method to replace a lost permanent tooth and to restore aesthetics and function.

Key learning points
• Autotransplantation is a viable option for the treatment of a missing tooth or for replacement of avulsed and traumatized tooth when a donor tooth is available.
• Autotransplantation is a therapeutic option for the substitution of missing anterior teeth in young patients who also need orthodontic treatment.

Keywords: autotransplantation, avulsion, orthodontics, tooth injuries.

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Introduction

Since the report of Slagsvold & Bjercke (1967), numerous studies (Slagsvold & Bjercke 1974, 1978, Andreasen 1981, Kristerson 1985, Andreasen et al. 1988, Tsurumachi & Kakehashi 2007, Sönmez et al. 2008) have confirmed that autotransplantation is a widely accepted method for the treatment of orthodontic problems with premolar or incisor...
agenesis in preference to space closure by orthodontic treatment. Likewise, traumatic injuries affecting anterior teeth and that require a prosthesis or orthodontic treatment may also be treated by autotransplantation, particularly when the extraction of premolar teeth is necessary because of malocclusion treatment.

Autotransplantation entails certain risks when performed with inappropriate surgical techniques and at an inappropriate stage of root development. These include pulpal necrosis and inflammatory or replacement root resorptions. However, the long-term results of the treatment obtained in the Copenhagen University Hospital (Andreasen et al. 1990a) are encouraging. This success depends upon the use of a standardized surgical technique under aseptic conditions in which one must take into account the tooth to be autotransplanted, the region into which it is transplanted and the preparation of receptor site, as well as the position occupied by the transplanted premolar. Subsequent monitoring of pulp and periodontal healing is also mandatory (Andreasen et al. 1990c).

Ideally, the treatment of an avulsed tooth is replantation of the tooth into its own socket within 20–30 min of injury or keeping the tooth in an appropriate storage medium until the patient can be treated by a dentist (Andreasen et al. 1995). Kinirons et al. (2000) examined variations in the presentation and treatment of 128 reimplanted permanent incisor teeth in children and determined the effect of these factors on the prevalence of external root resorption. They found a lower prevalence of resorption when the period of dryness was ≤5 min. The authors concluded that the degree of contamination and the period of dryness were the major risk factors for resorption.

If the tooth is not replanted, the alternative choices are orthodontic treatment to either close the space or preserve it for future restoration with a fixed or removable prosthesis or a dental implant. The type of restoration depends on factors including the patient’s age, amount of alveolar bone present and the integrity of the adjacent teeth (Sönmez et al. 2008). Another option is the transplantation of a tooth into the space left by the avulsed tooth. In this respect, the use of premolar autotransplantation in cases of agenesis or traumatic loss of maxillary incisors has been well documented (Kristerson 1985, Bowden & Patel 1990). Thus, autotransplantation becomes a solution for those patients who have suffered trauma accompanied by the loss of maxillary incisors and who also require also need orthodontic treatment involving extraction of premolars.

The aim of this case report is to present the delayed autotransplantation of a mandibular premolar into the space left by an avulsed permanent maxillary central incisor followed-up 14 years later.

**Case report**

In 1991, a 10-year-old child attended 3 months following a traumatic injury to the maxillary anterior region (Fig. 1). The patient was healthy. After the case history, a complete clinical
and radiologic examination was performed. Diagnosis included avulsion of tooth 11, enamel and dentine fractures and pulpal necrosis in tooth 21, with periapical radiolucency. Carious lesions in permanent molars and root remnants of primary molars were evident. The patient had a Class I occlusion with crowding and arch-length loss because of early loss of second primary molars and mesial drifting of first permanent molars.

After performing root canal treatment on the central incisor (21), restoration of the permanent molars and extraction of root remnants were performed. Extraction of the maxillary and mandibular first premolars was agreed. Tooth 44 was selected for transplantation (stage 3: 1/2 of root development; Moorrees et al. 1963) (Fig. 2). The remaining spaces were subsequently closed after the eruption of the mandibular second bicuspids and maxillary canines.

The patient was sedated using midazolam (0.2 mg kg⁻¹ of patient weight) (Andreasen et al. 1990a), and local anaesthesia, and sedation provided nitrous oxide. The autotransplant was performed under antibiotic cover with penicillin (2–4 000 000 of units) for 4 days, the first dose being administered intramuscularly 1 h prior to surgical intervention.

An intraoral periapical radiograph was taken to measure the length of the premolar tooth to be transplanted. A mucoperiosteal flap was performed in the area leaving the alveolar bone exposed, and a socket was prepared using a low-speed handpiece at 1000 and 2000 rpm, with a bone drill and internal irrigation of saline solution (Fig. 3). The socket was prepared 2 mm deeper and 1 mm wider than the premolar root and blocked with gauze to avoid contamination with saliva and the formation of coagulations until the transplantation occurred.

The donor tooth was removed atraumatically using gentle luxation movements and making a gingival incision and incising the cervical part of the periodontal ligament (Fig. 4). After that, the extracted tooth was removed with gauze and introduced into the socket created in the incisor region (Figs 5 and 6). The tooth was placed with respect to its eruption level and in an infraocclusion position. Then, the tooth was splinted with 3-zero suture silk by means of two bucco-lingual crossed points supporting its occlusal surface.

Once the autotransplantation process was completed, clinical and radiological examinations were undertaken at 4 and 8 weeks, 6 months (Figs 7 and 8), and 12 months and, finally, every year after surgical intervention, according to the following protocol:

1. Clinical exploration included analysis of transplanted tooth position by relating its cervical level with that of the other incisors; degree of mobility; gingival state (gingivitis, gingival retraction, papillary hyperplasia); premature occlusal contacts; percussion (to detect possible ankylosis) and pulp vitality tests.

Figure 2 Pre-operative radiograph of the donor tooth (44).
Radiological exploration included analysis of root growth, comparing it to that of non-transplanted premolar; possible pulp or periodontal complications such as apical periodontitis and root resorptions (inflammatory, replacement resorptions or ankylosis and surface resorptions) and pulp and root canal obliteration.

Post-surgical follow-up began 1 week after intervention and included radiological control and the removal of the two sutures (Andreasen et al. 1990b, Paulsen & Andreasen 1998).

Figure 3 Creation of the socket.

Figure 4 The donor tooth was removed atraumatically.

Figure 5 The extracted tooth was introduced into the socket in the incisor region.
Mobility was normal from the eighth week onwards. No premature occlusal contacts were detected at any time and the sound of percussion was normal at all times (Table 1). An electric test was performed 6 months after intervention with negative results. Root growth was measured by means of a ruler and a periapical radiograph taken using a paralleling technique and found to be similar to that of other non-autotransplanted premolars. Pulp chamber obliteration began 6 months after intervention. After 2 years, pulp obliteration extend to one-third of the root, and after 4 years, the obliteration
extended to two-third of the root. The follow-up was subsequently interrupted after 10 years (Table 1).

Restoration of the tooth with a hybrid composite material was completed 6 months after autotransplantation. After that, orthodontic treatment was carried out to place the transplanted tooth at the same level as the other incisors. Follow-up was completed throughout the first 4 years (Fig. 9).

Table 1  Clinical and radiological findings during the follow-up

<table>
<thead>
<tr>
<th>Mobility</th>
<th>Gingival state</th>
<th>Premature occlusal contacts</th>
<th>Pulp test</th>
<th>Root growth (mm)</th>
<th>Pulp obliteration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset</td>
<td>++</td>
<td></td>
<td></td>
<td>19.5 (3/4R)</td>
<td></td>
</tr>
<tr>
<td>4 weeks</td>
<td>+</td>
<td>Normal</td>
<td>–</td>
<td>19.5</td>
<td>–</td>
</tr>
<tr>
<td>5 weeks</td>
<td>–</td>
<td>Normal</td>
<td>–</td>
<td>19.7</td>
<td>–</td>
</tr>
<tr>
<td>5 months</td>
<td>–</td>
<td>Normal</td>
<td>–</td>
<td>20.5</td>
<td>Part of chamber</td>
</tr>
<tr>
<td>1 year</td>
<td>–</td>
<td>Normal</td>
<td>+</td>
<td>21</td>
<td>All chamber</td>
</tr>
<tr>
<td>2 years</td>
<td>–</td>
<td>Normal</td>
<td>–</td>
<td>22.5</td>
<td>One-third of root</td>
</tr>
<tr>
<td>3 years</td>
<td>–</td>
<td>Normal</td>
<td>–</td>
<td>22.5</td>
<td>Two-third of root</td>
</tr>
<tr>
<td>4 years</td>
<td>–</td>
<td>Normal</td>
<td>–</td>
<td>22.5</td>
<td>Total</td>
</tr>
<tr>
<td>14 years</td>
<td>–</td>
<td>Mesial</td>
<td>–</td>
<td>22.5</td>
<td>Total</td>
</tr>
</tbody>
</table>

Figure 8  Clinical view after 6 months.

Figure 9  Clinical view after 4 years follow-up.
Fourteen years after autotransplantation, the patient returned for treatment and a further clinical and radiological examination carried out. Crown yellowing and marginal discolorations around composite restorations in the transplanted tooth and the left maxillary central incisor, as well as gingivitis, were evident (Fig. 10). Pulp sensibility tests were negative. Radiographs revealed that the root length of the transplanted premolar was similar to that of the non-autotransplanted premolars (Fig. 11). The pulp chamber and root canal of the transplanted tooth were completely obliterated, with complete periodontal healing.

Two indirect resin-composite restorations were placed using opalescent and highly light-refractive material (enamel HRi-Micerium®; Avegno, Genova, Italy) and, after the isolation of the teeth with a rubber dam, were cemented (Fig. 12).

**Figure 10** Clinical view 14 years after autotransplantation.

**Figure 11** Periapical radiograph 14 years after autotransplantation.
Discussion

Autotransplantation is a treatment option that has become widely accepted since 1960 in growing patients suffering from incisor loss and requiring orthodontic treatment. Previous reports (Czochrowska et al. 2002, Tsukiboshi 2002, Jonsson & Sigurdsson 2004) provided information on the survival of orthodontically displaced autotransplantations. Czochrowska et al. (2002) studied the survival rate of 33 autotransplants in 28 patients who received subsequent orthodontic treatment and throughout a follow-up period ranging between 17 and 41 years. They concluded that survival and success rates for teeth autotransplanted when the root was partly developed compared favourably in a long-term perspective with other treatment modalities for substituting missing teeth.

The same authors (Czochrowska et al. 2000) studied maxillary incisor–premolar transplantation evaluating aesthetics and satisfaction and concluded that in general most part of autotransplants were equal to contralateral transplant in terms of aesthetics and patient satisfaction. Only 18 % of patients were dissatisfied from an aesthetic viewpoint once the treatment had been completed. The most important aesthetic problems were colour change because of pulp obliteration and difference in mesiodistal width in the neck of the tooth.

When autotransplantation is planned, a throughout examination must be performed consisting of intraoral periapical and orthoradial radiographs both of the donating tooth and the receptor area, because appropriate osseous support is necessary for alveolar-bed preparation. Secondly, the tooth to be transplanted must be evaluated taking into account its degree of root development, dividing such development into seven stages, because it has been ascertained that the greatest success occurred in transplants performed during Moorrees’ stage 3 and 4 (Moorrees et al. 1963, Andreasen et al. 1990b), i.e. between half and three-fourth of root development (7 and 9 mm of length with open apex).

If there is no complication, post-surgical risk of pulp necrosis or root resorptions in transplanted premolars must be controlled by means of successive clinical and radiographic examinations (Andreasen et al. 1990b).

In the present case, creating the correct crown morphology prior to autotransplantation could have aided positioning of the autotransplanted tooth. However, at that moment, it was considered most important to complete the autotransplant as rapidly as possible. Good practice in autotransplantation involves the use of templates for the donor tooth to be used as drilling templates for preparation of the recipient site. The combination of spiral CT imaging and computer-aided prototyping to produce a surgical template for the donor tooth has been shown to be useful in increasing success rates by avoiding injury to the delicate
donor tooth (Lee et al. 2001). Recently, Keightley et al. (2010) have used cone beam CT to generate an image of the donor and recipient site as well as the transplanted tooth. This data were then used to fabricate a 3D model of the donor tooth to allow preparation of the implant site prior to autotransplantation. Additionally, a non-invasive, objective and painless method, such as laser Doppler flowmetry (Jafarzadeh 2009), is available to ascertain revascularization and monitoring of pulpal responses in the transplanted tooth.

Conclusions

Autotransplantation is a viable option for the treatment of a missing tooth or for replacement of avulsed and traumatized tooth when a donor tooth is available. It is also a therapeutic option for the substitution of missing anterior teeth in young patients who need orthodontic treatment.

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References