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Metal tooth-like surgical templates for tooth autotransplantation in adolescents

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Abstract – *Objectives*: The aim of this study was to suggest a way to fabricate surgical templates to assist the surgeon in preparing the recipient socket when performing premolar autotransplantation. *Methods*: Premolars used previously for extractions of periodontal ligament (PDL) fibroblasts were used in this study as archetype of models for tooth transplantation. Eighty-four mandibular and maxillary first and second extracted premolars were reviewed. All teeth were extracted for orthodontic reasons. From these teeth, eight teeth were selected to serve as archetype of models in which all the other teeth were at equal size or smaller in maximum 2 mm in M-D or B-L dimension. These teeth were sent to dental technician to perform identical archetype stainless steel templates. During autotransplantation immediately following donor tooth extraction, the appropriate template is chosen out of the toothlike stainless steel surgical templates and the donor tooth is then immediately replaced in its socket. This enables the surgeon to prepare the recipient site without manipulating the donor tooth and thus preventing damage to the PDL cells of the donor tooth. Only after the recipient site had been prepared to the appropriate size and shape according to the template, the donor tooth is removed from its socket, immediately placed at the recipient site and splinted as recommended. *Conclusions*: The advantage of the presented metal tooth-like surgical templates described in this study is that a set of stents has been produced by replicating different common shape adolescent premolars that reflect the biological variation in size and shape of these teeth.

Tooth autotransplantation is the surgical transposition of a donor tooth from one site to another recipient site within the same individual. During autotransplantation, a donor tooth is transplanted into either an extraction site or a surgically prepared artificial socket at the recipient site (1). Autotransplantation is a well-recognized technique for restoration of missing anterior teeth resulted from developmental disturbances or from traumatic injuries (2, 3). Recent reports have shown high success rates for this procedure over time (4–6). One of the most prevalent and important applications of this technique is to transplant premolar tooth to the maxillary anterior region to replace an incisor after loss due to trauma (7, 8).

There are several proposed surgical techniques for autotransplantation, all based on a-traumatic handling of the donor tooth. Immediately after extraction, the extracted root should be evaluated for its size and shape and preserved in appropriate storage medium or preferably in its original socket. The recipient site is then prepared to appropriate dimensions to accommodate the donor tooth in the best possible position, without applying pressure on the periodontal ligament of the donor tooth. The donor tooth is then tested in the recipient socket with light pressure to examine whether the socket was prepared to an appropriate size (9–11). The use of a surgical template instead of the transplanted tooth itself, during the preparation of the socket, might minimize the unnecessary additional periodontal ligament (PDL) trauma caused by the adjustment of the donor tooth in the artificial recipient socket (9). Day et al. have proposed and produced rounded surgical templates, which resemble the different sizes of premolar transplant roots (9). They suggested that fabrication of these surgical stents will improve the surgeon's skill and minimize the trauma to the PDL of the donor tooth and reduce the extra-alveolar time of transplanted tooth, thus increasing the success rate of the transplantation. Clokie et al. reported the use of an acrylic replica of the donor tooth, and its dimension was determined according to presurgery radiograph (12). Others suggested the use of computed tomography (CT) for individual tooth template preparation (13, 14), although this method required additional radiation as well as high cost for the patient.

The aim of this study is to describe and suggest a simple and cost-effective method of fabricating metal tooth-like surgical templates for tooth autotransplantation in adolescents.

Metal tooth-like surgical templates fabrication

Premolar teeth used in previous studies for extraction of PDL fibroblasts were stored at −16°C and used as

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duplicate templates in this study. The premolars were collected during 1998–2009. All premolars were extracted from children undergoing orthodontic extraction. Written consent was obtained at that time from all patients' parents before extraction, which was performed free of charge, and the patients were informed that the teeth will be used for research.

From a stock of eighty-four extracted premolars that were extracted for orthodontic purpose, eight teeth were chosen as archetype of models for tooth transplantation (four upper and four lower premolars). The selection of teeth was on the basic measurement that at least one model (of eights) will be at the same size or larger by maximum of 2 mm in M-D or B-L dimension from the other teeth in the collection. This was based on the recommendation that the size of recipient socket should be maximum of 2 mm larger than the socket of the donor tooth (6, 11). These teeth were sent to dental technician to perform identical archetype stainless steel templates (Fig. 1).

During autotransplantation immediately following donor tooth extraction, the appropriate template is chosen out of the tooth like stainless steel surgical templates (Fig. 2), and the donor tooth is then immediately replaced and stored in its socket until replantation. This enables the surgeon to prepare the recipient site with minimum manipulation of the donor tooth, preventing damage to the PDL cells of the donor tooth (Fig. 3). Only after the recipient site had been prepared to the appropriate size and shape according to the template, the donor tooth is removed from its socket, immediately placed at the recipient site and splinted as recommended (Fig. 4).

Discussion

Tooth replacement after traumatic injury to the anterior teeth is one of the major challenges in paediatric dentistry, especially because this treatment can provide permanent solution to early loss of anterior tooth when the growth of the alveolar bone is incomplete. Moreover, this treatment can even induce correction of bone defects that occurred following replacement resorption development (15). Premolars have been suggested to be the most appropriate teeth for transplantation in order to replace an incisor after loss due to traumatic injury (7, 8).

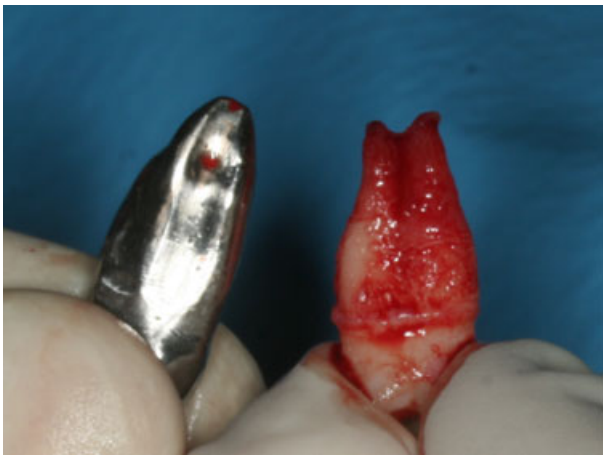


Fig. 2. The appropriate template is chosen out of the toothlike stainless steel surgical templates.

During socket preparation, before transplantation, the surgeons usually rely on subjective visual estimation and personal experience. Manufacturing a three-dimensional toothlike model may offer more information related to the donor tooth and preparation of the recipient region. Using metal, autoclavable, reusable toothlike surgical templates as presented here could serve as a simple and cost-effective method for tooth autotransplantation in adolescents. The metal samples were made by copying selected representative extracted teeth using standard technical laboratory work. This could be rather easily carried out in every dental clinical setting.

As opposed to the metal rounded surgical templates suggested by Day et al. (9), the presented technique provides a tooth-formed template that resembles more accurately the shape of the donor root. Moreover, this method does not require additional irradiation for patients and costs as in the cone beam CT (CBCT) methods that were proposed recently (13, 14). Furthermore, CBCT was found to have less contrast resolution than CT, which can result in less accuracy for segmentation (14).

There are several factors that influence the prognosis of a transplanted tooth. Preservation of the periodontium of the grafted tooth as well as reducing the

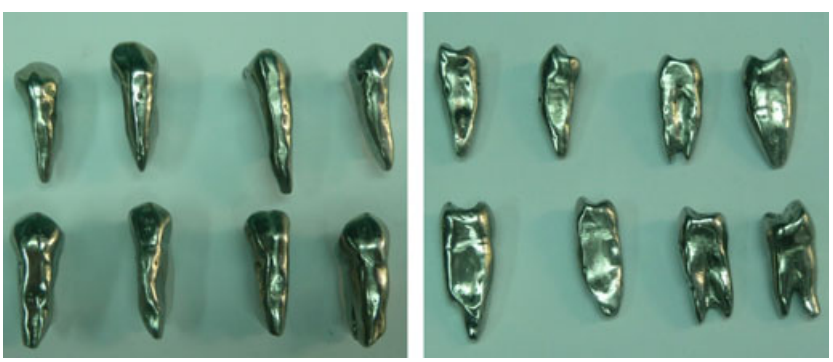


Fig. 1. Metal tooth-like surgical templates for tooth autotransplantation.

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Fig. 3. The toothlike stainless steel surgical templates are used to prepare the recipient site without manipulating the donor tooth and thus preventing damage to the PDL cells of the donor tooth.

extra-oral time of the donor tooth during transplantation play an important role in preserving the vitality of the periodontal ligament cells and thus are key factors for successful clinical outcome (10, 12, 14, 16, 17). The metal tooth-like surgical templates might be beneficial in proper and more accurate socket preparation of the recipient area without damaging the donor tooth PDL.

Excessive trauma may lead to irreversible replacement resorption (ankylosis). The smaller the area of mechanical damage on the root, the more likely it is to heal with new cementum and a viable PDL; a larger area of damage will result in ankylosis with areas of bone attached to the root (9, 10). Extra-alveolar time alters the pH, osmotic pressure and dehydration pressures on the PDL cells and may also reduce the likelihood of periodontal healing (10). Increased handling when trying the donor tooth in the recipient site socket might prolong extra-oral time, and each attempt carries a risk of increased bacterial contamination.

The advantage of the presented metal tooth-like surgical templates described in this study is that a set of stents has been produced be replicating different common shapes adolescent premolars that reflect the biological variation in size and shape of these teeth. They enable the surgeon to choose the most appropriate tooth shape at the time of surgery.

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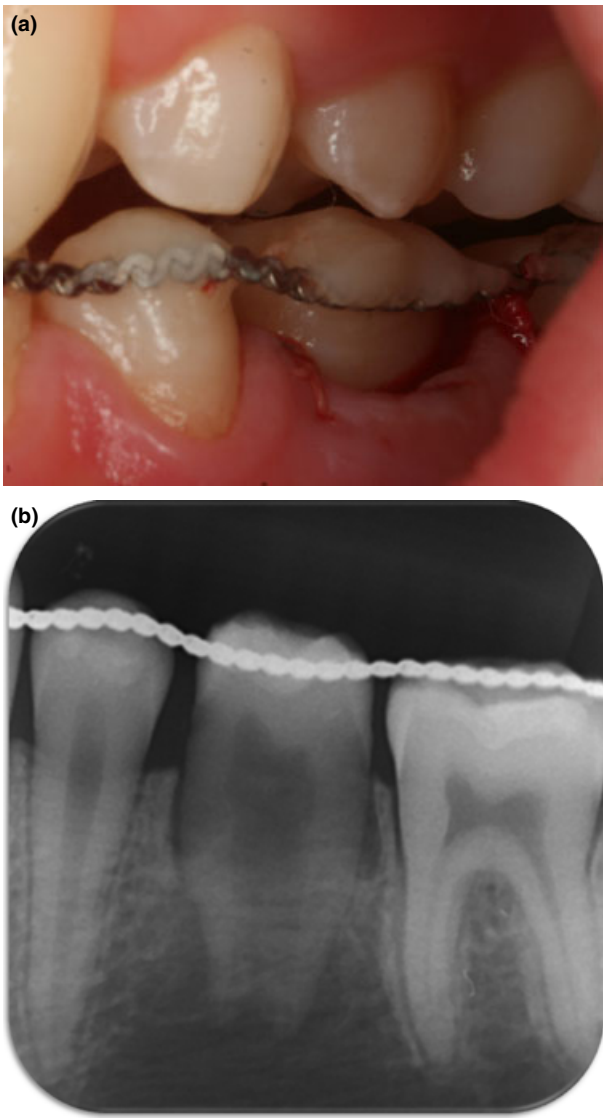


Fig. 4. After the recipient site had been prepared to the appropriate size and shape according to the template, the donor tooth is removed from its socket, immediately placed at the recipient site and splinted [(a) clinical view; (b) radiographic view].

Conflict of Interest

The authors have no conflict of interests related to the manuscript.

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