

Autotransplantation of an impacted maxillary canine using Rapid Prototyping : A case report

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Abstract

Management options for impacted maxillary canines can include (1) continued observation, (2) extraction of the primary canine to aid spontaneous eruption, (3) uncovering and bonding of the impacted tooth and its eruption using orthodontic traction, (4) autotransplantation, and (5) extraction followed by prosthetic replacement. Autotransplantation should be considered when the degree of malposition is too severe to correct by orthodontic alignment. The present report describes the management of an ectopic eruption of the left maxillary canine in an 10-year-old girl. The treatment included the extraction of primary maxillary left canine and the autotransplantation using a Rapid Prototyping model. By using RP model to contour the recipient bone and check for fitting in the prepared socket, the extra-oral time can reduce. The autotransplanted canine showed mobility within normal limit, negative response to percussion and positive to electric pulp test after 6 months.

Key words : Impacted canine, Autotransplantation, Rapid Prototyping

I . INTRODUCTION

Impacted teeth are those with a delayed eruption time or that are not expected to erupt completely based on clinical and radiographic assessment¹⁾. The maxillary canine is second next to the mandibular third molar in its frequency of impaction. The prevalence of impacted maxillary canines is 12% in the general population^{2,3)}. Management options for impacted maxillary canines can include (1) continued observation, (2) extraction of the primary canine to

aid spontaneous eruption, (3) uncovering and bonding of the impacted tooth and its eruption using orthodontic traction⁴⁾, (4) autotransplantation⁵⁾, and (5) extraction followed by prosthetic replacement⁶⁾. Autotransplantation is the process in which tooth, usually impacted, is surgically transferred to correct position or to replace another tooth in the same alveolus⁷⁾. Autotransplantation should be considered when the degree of malposition is too severe to correct by orthodontic alignment.

Medical Rapid Prototyping (MRP) is defined as the manufacture of dimensionally accurate physical models of human anatomy derived from medical image data using a variety of Rapid Prototyping (RP) technologies. It has been applied to a range of medical specialties, including oral and maxillofacial surgery⁸⁻¹⁴⁾, dental implantology¹⁵⁾, neurosurgery^{16,17)}, and orthope-

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dics¹⁸⁾. Lee et al.¹⁹⁾ reported a lower extra-oral time and improved contact between the donor tooth and recipient bone after performing autotransplantation using Rapid Prototyping for a similar model to the donor tooth.

This case report demonstrates an autotransplantation of an impacted maxillary canine using Rapid Prototyping in a 10-year-old girl.

II. CASE REPORT

Clinical history

A 10-year-old girl came for her first visit with her parents. Their chief complaint was ectopic eruption of the left maxillary canine. Clinical examination showed a retained left maxillary deciduous canine and spacing of maxillary anteriors(Fig. 1). The radi-

ographic analysis revealed that the left maxillary canine was impacted, and its crown was in buccal portion to the root of the left maxillary second premolar(Fig. 2). The location of the impacted canine was



Fig. 1. Initial clinical examination showing a retained left maxillary deciduous canine and spacing of maxillary anteriors.



Fig. 2. Radiographs revealing the left maxillary canine with open apex buccally impacted.



Fig. 3. The cusp of the impacted canine was located in sector 3 according to the criteria proposed by Crescini et al.²⁰⁾. The inclination of impacted maxillary canine was 113°, which is the angle between the long axis of the impacted maxillary canine and midline. The distance between the cusp of the canine and the occlusal plane was 17mm.

assessed by panoramic image using a criteria proposed by Crescini et al²⁰⁾. The cusp of the impacted canine was located in sector 3. The inclination of the impacted maxillary canine was 113°, which is the angle between the long axis of the impacted maxillary canine and midline. The distance between the cusp of the canine and the occlusal plane was 17mm. The left maxillary canine had an open apex(Fig. 3). The patient's medical history was noncontributory.

The canine was in a difficult malposition, so that orthodontic treatment was impossible. After discussion of treatment options, autotransplantation was selected. The treatment included the extraction of the left maxillary deciduous canine and orthodontic pre-treatment prior to autotransplantation. Orthodontic pre-treatment with mesial and vertical traction of the impacted maxillary canine may bring the maxillary canine to a more favorable position and facilitate extraction and autotransplantation²¹⁾.

Orthodontic procedure

A full thickness flap was raised to expose the cortical plate, and the deciduous canine was removed. Cortical bone was removed to provide access to the crown, and follicular socket was eliminated. The chain was passed through guiding groove on cortical bone and fixed to impacted canine by a bonded button(Fig. 4). The flap was then repositioned and sutured in its original seat.

By means of fixed and removable appliances, a sufficient space was made in the maxillary arch for the impacted canine. At the same time orthodontic traction was performed with a force of approximately 60 ~100mg for 8 months. When the space opening was completed and the canine was located at buccal side of the left maxillary first premolar, the autotransplantation was performed(Fig. 5).

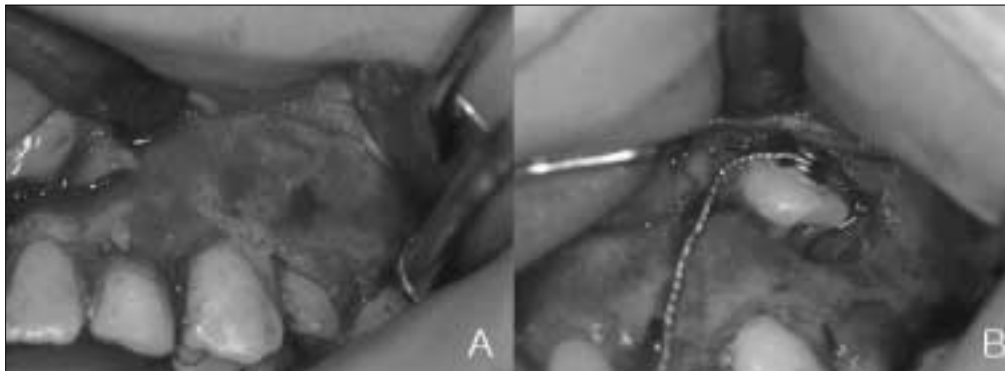


Fig. 4. Surgical exposure(A) and bonding of a button to the canine(B).



Fig. 5. By means of orthodontic appliances, a sufficient space was made for the impacted canine and the canine was located at the buccal side of the left maxillary first premolar.

Autotransplantation

Computed tomography (CT) was taken for pre-examination of the donor tooth and the recipient site. The size of the donor tooth and the recipient site were measured. Three-dimensional data (DICOM format; digital imaging and communications in medicine) of the donor tooth using a CB MercuRay® (Hitachi medical corp., Japan) were obtained. A slit thickness was 0.20-mm. DICOM CT files were imported into CT image processing software (Vwork 5.0, Cybermed, Seoul, Korea), which built up the image and constructed the virtual 3D model(Fig. 6). The software sent the Structured Triangular Language (STL) file to the Rapid Prototyping machine for fabrication of the donor tooth model by 3D printing.

250mg of systemic amoxillin (Ilsung Augumentin®, Seoul, Korea) was administrated one hour before

surgery. After local anesthesia, a full thickness flap of the recipient site was reflected and the recipient bone was prepared using surgical bur with saline ir-

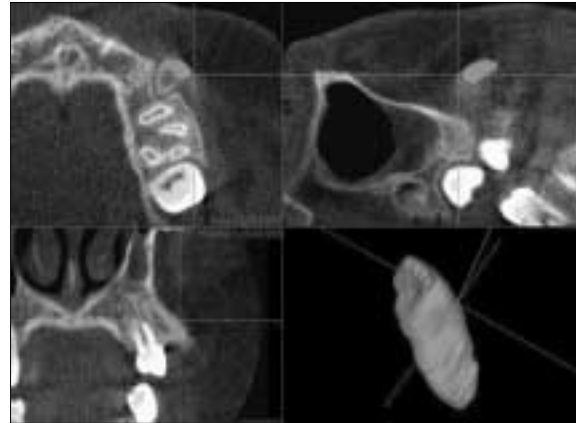


Fig. 6. 3-D reconstructed image.

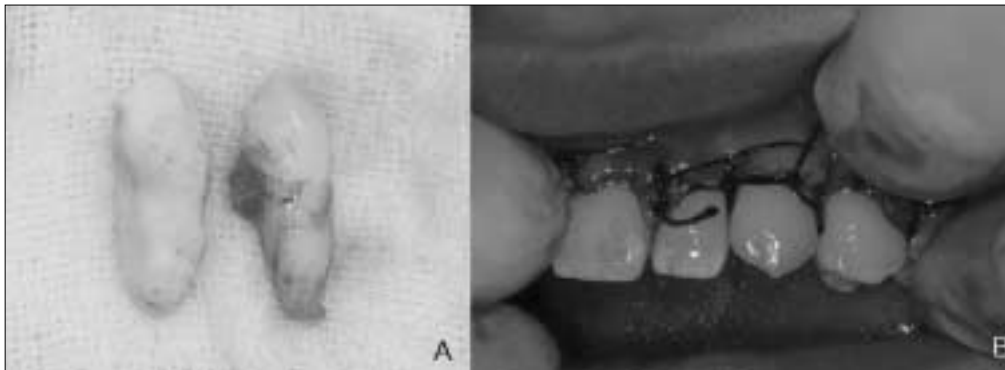


Fig. 7. Autotransplantation of the canine. A. RP model and the donor tooth. B. The donor tooth is placed into the prepared socket.

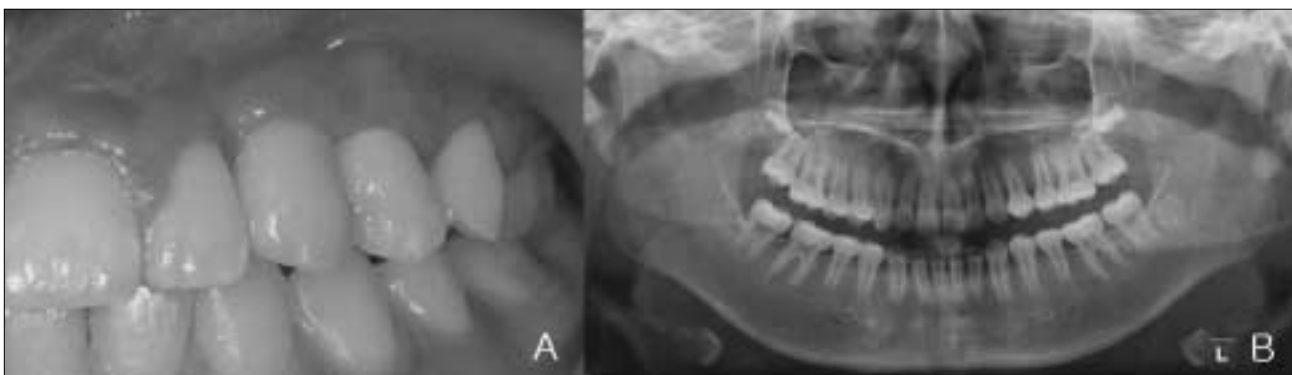


Fig. 8. 6 month after autotransplantation. A. Intra-oral view. B. Panoramic view.

rigation until the model of the left maxillary canine fit well into recipient site. After performing an intra-crevicular incision around the crown, the canine was extracted with minimal injury and placed into the recipient bone socket with slight sub-occlusion (Fig. 7). Extra-oral time was about 50 seconds and the tooth was stored in Hank's balanced salt solution (HBSS) during the extra-oral period. The transplanted tooth was stable enough for the fixation with modified anchor suture and periodontal pack.

The patient was given systemic amoxicillin (Ilsung Augumentin®, Seoul, Korea), 750mg tid for 7 days, and mouth rinsing with 0.1 % chlorhexidine (Hexamedine®, Bukwang Pharmaceutical Co., Seoul, Korea) was also recommended. The sutures and periodontal pack were removed 1 week after surgery. No endodontic treatment was planned unless the check-up radiographs revealed complication because the donor tooth had an open apex.

The patient was recalled every 2 weeks for 3 months, and every 1 month thereafter. Registrations were made regarding tooth mobility, percussion, sensitivity upon electric stimulation, occlusal contact, periodontal condition and radiographic signs of root resorption. The autotransplanted canine showed mobility within normal limit, negative response to percussion and normal gingival condition with pocket depths below 3mm. The canine responded positively to electric pulp test after 6 months. The radiograph showed continuance of lamina dura and no root resorption (Fig. 8).

III. DISCUSSION

The prognosis for successful autotransplantation is dependent on a number of factors, such as root development, position of the tooth, surgical technique, extra-oral time, type of splinting, fixation period and endodontic technique^{22,23}. The revascularization of the pulp appears more predictable in roots with open apices than in roots with closed apices. The pulp healing was the usual finding in teeth at stage 1~5 of root development and a diameter of the apical foramen above 1mm had a low risk of pulp necrosis²⁴. Continued root development after transplantation can also be expected if a donor tooth is immature and Hertwig's epithelial sheath is pre-

served around the apices²⁵. However, the amount of root development to be expected cannot be predicted. Therefore it is favorable for donor tooth to be its maximal length as possible. Tsukiboshi²³ recommended that considering pulp healing and continued root development, the ideal autotransplantation time of a tooth with incomplete root formation is at the stage 4~5 of root development. In this case report, the left maxillary canine had an open apex at the operation and responded positively to EPT after 6 month.

A vital periodontal ligament is essential for the long term survival of autotransplantation. Loss of vitality of periodontal ligament could lead to root resorption²⁶. Therefore it is important to minimize the extra-oral time and store the donor tooth in a physiologic storage medium during the extra-oral period in order to preserve the periodontal ligament. Lee et al.¹⁹ reported that the average extra-oral time was 7.4 min in the autotransplantation procedure using Rapid Prototyping. In this study, the extra-oral time was about 50 seconds and the tooth was stored in Hank's balanced salt solution (HBSS) throughout the extra-oral time. No visible root resorption was observed on radiograph.

The gap between the recipient site and the root surface of the transplanted tooth is an important factor in autotransplantation. When the root surface of the transplanted tooth is too close to recipient site, it is likely to occur ankylosis due to mechanical damage of periodontal ligament. On the other hand, when the recipient socket is too wide, the bone healing would be delayed²³. Optimal contact with the recipient site can improve blood supply to periodontal ligament and provide better wound healing. Therefore the accuracy of RP model compared with real donor tooth may affect the prognosis of autotransplantation. Lee et al.²⁷ evaluated the dimensional errors among the real tooth, the 3D CT image and RP model and found that an average of absolute error was 0.291mm between the real teeth and the RP model. In this case report, the RP model which was fabricated with 3D printing method was about 1mm larger than real tooth. Several studies^{19,28} have been reported a successful rate of an autotransplantation when the gap between the recipient site and the root surface of the transplanted tooth was about 1~2mm

within the acceptable error. However the model in this case report did not show the fine dilaceration of the real donor tooth.

The type and period of splinting may have an effect on pulpal and periodontal healing of replanted and autotransplanted teeth. Bauss et al.²⁹⁾ showed in a study of autotransplanted immature third molars that ankylosis and pulp necrosis increased significantly after rigid fixation for 4 weeks compared with suture splinting for a week and also prolonged rigid fixation group revealed a significantly shorter final root length and root length increment. In this case report, the fixation was made with modified anchor suture and periodontal pack for 1 week because the transplanted tooth was stable.

By using RP model to contour the recipient bone and check for fit in the prepared socket, the number of trials with the real donor tooth may decrease. Therefore RP model can help to minimize the extra-socket time and the possible injury of transplanted tooth during the process of autotransplantation. Also it may improve the fitness between the donor tooth and recipient site. Especially in the case of impacted tooth, the use of a RP model seems to provide significant advantages in the diagnosis, treatment planning, and surgical procedure.

The present report describes the management of an impacted left maxillary canine in an 10-year-old girl. The treatment included the extraction of primary maxillary left canine, the orthodontic pre-treatment and the autotransplantation using a Rapid Prototyping model. The autotransplanted canine showed mobility within normal limit, negative response to percussion and positive to electric pulp test after 6 months.

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국문초록

Rapid Prototyping을 이용한 상악 매복 견치의 자가이식 치험례

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매복치의 치료는 발생 원인, 치아 발육 상태, 매복 위치 및 맹출 경로, 맹출 공간 여부, 환자의 연령이나 협조도 등을 고려하여 시행하며 방해 요인 제거 후 자연 맹출 관찰, 매복치의 외과적 노출 후 교정적 견인, 매복치의 재위치 또는 치아이식, 발거 후 보철수복을 할 수 있다. 이 중 치아이식은 매복치가 맹출 경로를 크게 벗어나 외과적인 노출과 교정적 견인이 어려운 경우 시행할 수 있다. 자가치아이식의 성공을 위해 이식치아의 외상을 최소화하며 치주인대의 생활력을 보존하는 것이 중요하다.

본 증례에서는 상악 좌측 견치의 미맹출을 주소로 내원한 10세 여자 환자에서 Rapid Prototyping model을 이용하여 자가치아이식술을 시행하였다. RP technique을 이용하여 제작한 공여치의 모델로 수용부의 골와동 형성을 공여치 발치 전에 미리 시행함으로써 공여치의 구강 외 소요시간을 단축시키고 공여치를 수용부에 여러 번 시적할 때 생길 수 있는 치근 손상을 최소화할 수 있었다. 치료 후 상악 좌측 견치는 6개월 후 치근 흡수 등의 합병증 없이 정상 치아 동요도와 타진시 음성을 나타내었으며 전기치수검사서 양성 반응을 보였다.

주요어 : 매복 견치, 자가이식, Rapid Prototyping