Rapid Prototyping as an Adjunct for Autotransplantation of Impacted Teeth in the Esthetic Zone

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Autotransplantation of teeth, introduced by Slagsvold and Bjercke more than 40 years ago,1 is a proven option either for substitution of missing teeth or for replacement of avulsed and traumatized teeth when the original donor teeth are available.2 In cases of severely impacted teeth, it can avoid the need for complex traction mechanics and the risks of side effects on adjacent teeth while reducing overall treatment time.3 The procedure requires viable periodontal ligament cells around the tooth to be transplanted. It is also technique-sensitive, necessitating proper preparation of the recipient site, in the exact size and shape of the donor tooth and root, to minimize the time the donor tooth remains outside the oral cavity during surgery.

Rapid prototyping of impacted donor teeth can be a useful adjunct to autotransplantation in these cases. A three-dimensional replica of the impacted tooth is printed by stereolithography (STL) from a cone-beam computed tomography (CBCT) scan to aid the surgeon in preparation of the socket or recipient site. STL produces complex 3D physical models by solidifying one horizontal layer at a time, with stepwise submergence along the vertical axis.4 These 3D replicas can provide significant advantages in terms of the accuracy of diagnostics and treatment planning.

Fig. 1 Cone-beam computed tomography of maxillary section, showing impacted left central incisor.

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Procedure

After the area of concern is scanned by CBCT, appropriate sections are obtained in the form of Digital Imaging and Communications in Medicine (DICOM) version 3 files (Fig. 1). These files are then digitally extracted and converted to a printable format using Anatomage InVivo* software version 4.3 (Fig. 2). The EnvisionTEC** Perfactory Standard 3D printer (Fig. 3A) makes a replica model from the STL files (Fig. 3B), using either resin or starch.

Case Report

A 24-year-old male presented with a horizontally and palatally impacted upper left central incisor, overretained deciduous central incisors, and a mesiodens. Since the patient had reservations about the length of treatment and the predictability of surgical traction, autotransplantation of the tooth was planned. After leveling and alignment of the maxillary arch using an .022” Victory Series MBT*** preadjusted appliance (Fig. 4A), a rapid prototype was fabricated from a CBCT scan as described above.

During the surgical procedure, the socket was prepared (Fig. 4B) and the dimensions checked with the printed replica tooth (Fig. 4C). The impacted central incisor was then surgically extracted, maintaining an intact periodontal ligament surface. The donor tooth was positioned into its anatomical location (Fig. 4D). The transplanted tooth and the adjacent lateral incisor were etched, an everSTICK† fiber splint was placed, and flowable composite was laid and cured to fix the splint, which was left in position for eight weeks (Fig. 4E). Endodontic treatment was carried out during that period to prevent any chance of infection, root resorption, or ankylosis. After eight weeks of passive stabilization, orthodontic

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Fig. 3  A. EnvisionTEC** Perfactory Standard 3D printer. B. Rapid-prototype tooth replica.

Fig. 4  24-year-old male patient with horizontally and palatally impacted upper left central incisor, over-retained deciduous central incisors, and mesiodens.  A. After seven months of leveling and alignment using .022" Victory Series MBT*** preadjusted appliance. B. Surgical socket preparation. C. Prototyped replica used to check socket dimensions. D. Placement of extracted incisor in anatomical position. E. Transplanted tooth and adjacent lateral incisor etched, and everSTICK† fiber splint placed.  F. Alignment of auto-transplanted central incisor after 12 months of treatment.
treatment was reinitiated to align the tooth within the arch (Figs. 4F). Four months of finishing were required to obtain favorable esthetics and function (Figs. 5,6). The overall treatment time was 16 months.

Discussion

The challenge in treating patients with missing or impacted teeth is to achieve the best possible esthetic and functional results while ensuring long-term stability. The most common treatment modality for unfavorably impacted teeth—surgical extraction and prosthetic replacement or implant placement—has a questionable esthetic prognosis, especially in the anterior region where esthetic considerations are paramount.

In the case shown here, transplantation was chosen because no other orthodontic treatment option would bring the tooth into its normal anatomical position within the bone without the risk of injury to the adjacent lateral incisor root. Long-term studies of autotransplantation have reported a success rate of more than 90%. Today, with the availability of rapid prototyping, a 3D replica tooth can be fabricated to improve site preparation, thus allowing more precise treatment planning and making the surgical procedure more efficient.

Conclusion

Advantages of autotransplantation of impacted teeth in the esthetic zone include:
- The patient's own natural tooth can be used in its anatomical site, providing the best possible esthetic appearance.
- Because the transplanted tooth has a normal periodontal membrane, it can be subjected to orthodontic tooth movement.
- The transplanted tooth has the ability to erupt in synchrony with adjacent teeth, to adapt to functional demands, and to establish a normal marginal gingival contour.
- A transplanted tooth recovers its proprioceptive function, so that the patient retains natural chewing sensation.
- The risk of injury to adjacent teeth and the difficulty of root positioning associated with surgical traction are eliminated.
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REFERENCES


Fig. 6 Sequence of treatment (blue tooth represents rapid-prototyped model). A. After leveling and alignment. B. Socket preparation using prototyped replica. C. Extrusion mechanics after transplantation. D. Finishing stage with incisor in proper alignment.