IIUM Journal of Orofacial and Health Sciences (2024) 5(2): 226-235

CASE REPORT Open Access

Stereolithography (STL) model in dental autotransplant: A case report

Wan Nur Zahidah Wan Zullkefli[1], Khairul Bariah Chi Adam[2]*, Nabilah Rashida Jamali[2]

[1]*Dental and Maxillofacial Surgery Unit, Sultan Ahmad Shah Medical Centre (SASMEC @IIUM), International Islamic University Malaysia.*
[2]*Department of Oral and Maxillofacial Surgery and Diagnosis, Kulliyyah of Dentistry, International Islamic University Malaysia.*

Abstract

The goal of this case report was to describe the use of the stereolithography (STL) model in dental autotransplantation. This report described autotransplantation of the lower wisdom tooth (48) to replace a missing lower first molar (46) due to caries. This approach used an STL model of 48 fabricated in the laboratory from cone-beam computed tomography (CBCT) images to assist in recipient site preparation before autotransplant. In conclusion, the use of the STL model could potentially increase the success rate of autotransplantation as it can help to preserve the periodontal ligament (PDL) cells on the root surface of the donor tooth, shorten the extraoral time of the donor tooth, and provide optimum contact between the recipient bone and the root surface of the transplanted tooth.

Keywords: *3D model, autotransplant, CBCT, stereolithography, STL*

Received:
22 December 2023
Revised:
15 July 2024
Accepted:
16 July 2024
Published Online:
31 July 2024

How to cite this article:
Wan Zullkefli, W. N. Z., Chi Adam, K. B., & Jamali, N. R. (2024). Stereolithography (STL) model in dental autotransplant: A case report. IIUM Journal of Orofacial and Health Sciences, 5(2), 226-235. https://doi.org/10.31436/ijohs.v5i2.266

Article DOI:
https://doi.org/10.31436/ijohs.v5i2.266

***Corresponding author**
Address:
Department of Oral and Maxillofacial Surgery and Diagnosis, Kulliyyah of Dentistry, International Islamic University Malaysia, Jalan Sultan Ahmad Shah, Kuantan 25200, Pahang, Malaysia.

Telephone: +609 570 5466
Email address:
bariah@iium.edu.my

Introduction

Removable prostheses, fixed prostheses, autotransplantation, and implants are among the treatment options to replace missing teeth and restore masticatory functions and aesthetics. The selection of treatment depends on the patient's medical history, time constraints, financial status, the span of missing teeth, and bone quality.

Autotransplantation is defined as the transplantation of embedded, impacted, or erupted teeth from one site into extraction sites or surgically prepared sockets in the same person (Nimčenko *et al.*, 2013). A successful autotransplant can be presented as the absence of progressive root resorption, the presence of normal hard and soft periodontal tissues adjacent to the transplanted tooth, and a crown-to-root ratio <1(Czochrowska *et al.*, 2002; Intra *et al.*, 2014). To achieve a successful result, it is crucial to preserve the periodontal ligament cells on the root surface of the donor tooth, minimize the donor tooth's extraoral period, and ensure excellent adaptation between the recipient bone and the implanted tooth's root surface (Euiseong 2005). Hence, the use of the stereolithography (STL) model of the autotransplanted tooth can assist surgeons in reducing the number of unnecessary trials for fitting the donor tooth into the bone socket, resulting in less injury to the periodontal ligament cells on the root surface. It can also aid minimize donor tooth extraoral time and improve the interface between the donor tooth and the recipient bone.

Case Description

A 22-year-old Malay female was referred to us for management of pericoronitis of the lower right wisdom tooth (48). She had no underlying medical illness and no drug allergies. She complained of pain on both sides of her wisdom teeth. The intermittent, throbbing pain started four years ago and was alleviated by analgesics. The patient had a history of surgical removal of the lower right first molar (46) under local anaesthesia due to extensive caries.

Upon clinical examination, the patient had no significant abnormalities extraorally. Intraorally, the patient had fair oral hygiene with a missing tooth (46). Bilateral third molar teeth (38 and 48) were partially erupted, with only the mesial portion visible clinically.

An orthopantomogram (OPG) revealed vertically impacted 38 and 48. Tooth 48 had a slightly curved distal root at the apical end, while tooth 38 had a curved mesial root. Both teeth were not closely approximated to the inferior alveolar canal.

CBCT was used to assess the thickness, height, and quality of the bone at site 46, as well as the height, width, and length of the tooth 48. At site of 46, the bone thickness measured 0.79 cm, the width was 0.90 cm, and the height was 1.79 cm from the ridge to the inferior alveolar nerve canal. Conversely, the height of tooth 48 measured 1.63 cm from the mesial cusp to the mesial root, while the crown width of tooth 48 was 0.88 cm.

Figure 1. Orthopantomogram(OPG) of the patient taken during the first visit.

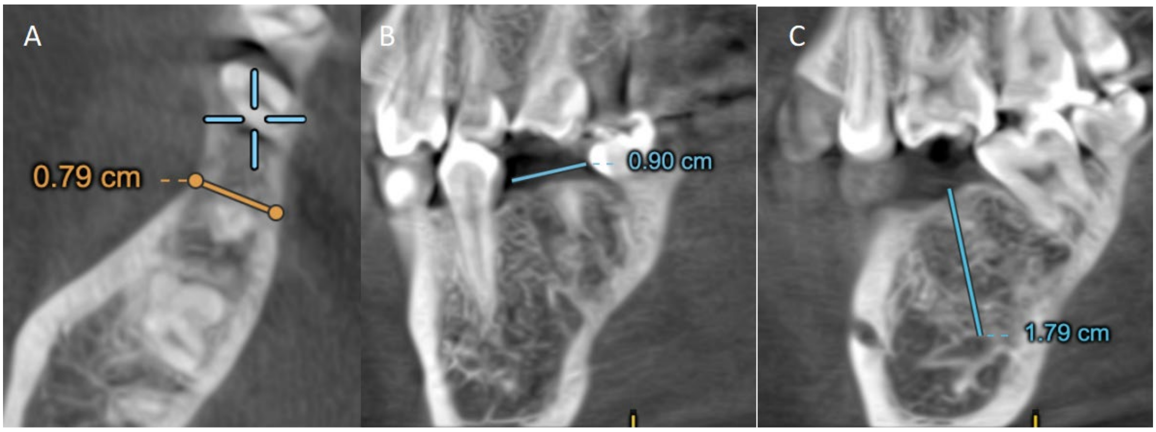

Figure 2. Cone Beam Computed Tomography (CBCT) at 46 region (preoperative). (A)Bone thickness (B)Width (C)Height from the ridge to the inferior alveolar nerve canal.

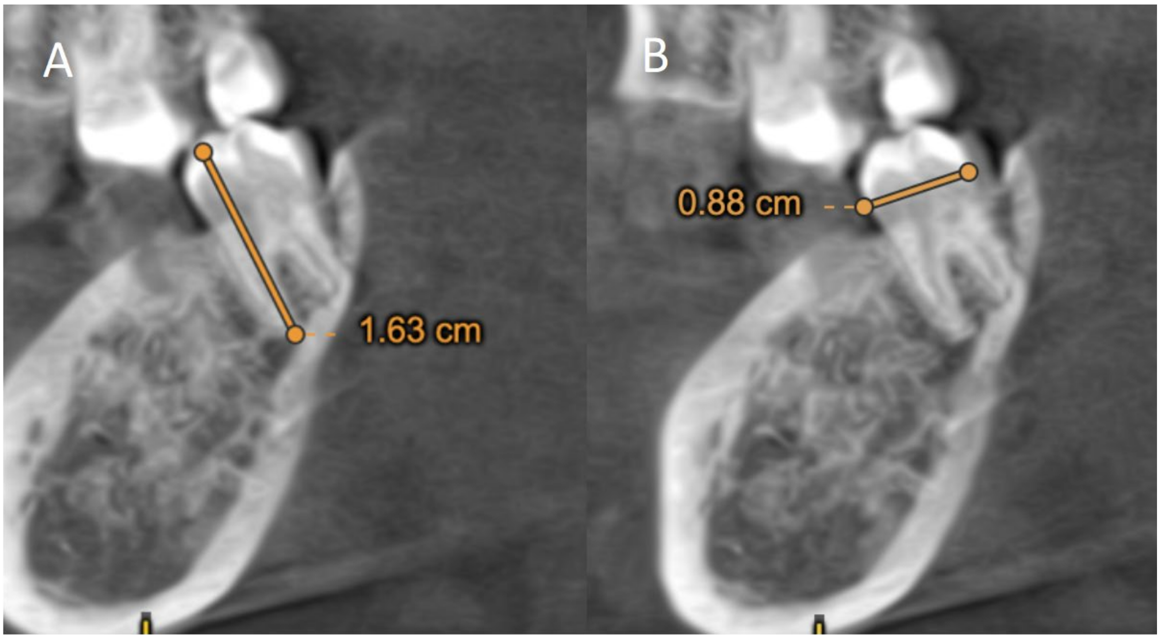

Figure 3. Cone Beam Computed Tomography (CBCT) of 48 tooth (preoperative). (A)Height of tooth 48 from mesial cusp to mesial root (B)Crown width.

The patient was presented with replacement options for tooth 46, including (1) a bridge, (2) an implant, or (3) autotransplantation of tooth 48 to site 46. The patient opted for autotransplantation of tooth 48 to site 46. CBCT images were then sent to 3D Gens laboratory for the fabrication of a stereolithography (STL) model of tooth 48. The material that was used for the fabrication of the STL model was stereolithography (SLA) material due to its high accuracy. The polymer resin was cured using ultraviolet lasers in the resin 3D printer to create the 48-tooth STL model.

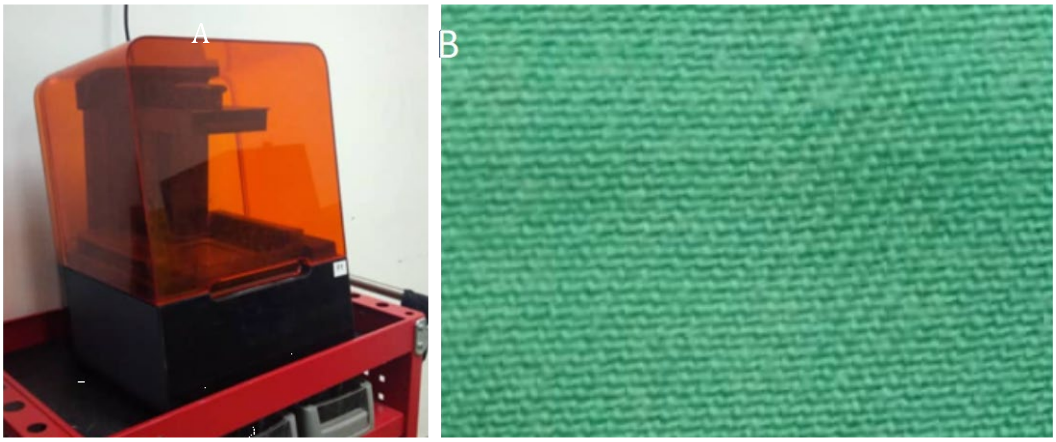

Figure 4. (A) SLA 3D printer (B) STL model of tooth 48.

The patient then underwent autotransplantation of tooth 48 to the site of tooth 46. During the surgery, the recipient site was first prepared using an implant surgical bur, and horizontal and buccal bone splits were also performed to create more space for the donor tooth. An STL model of the donor tooth was used to check for fit at the recipient site. Overall, it only took around 20–30 minutes to prepare the socket at the 36 region. When the fit of the STL model was satisfactory, the donor tooth was elevated out atraumatically and immediately placed at the prepared recipient site. Hence, the extraoral time is less than 15 seconds.

Bone removed during the socket preparation was placed on the buccal surface as an autograft due to buccal bone deficiency to support the tooth.

The donor tooth was then splinted to adjacent teeth with two twisted 0.5mm stainless steel wires bonded with composite and glass ionomer cement (GIC). Due to a thin lingual plate, the donor tooth was positioned buccally and slightly below the occlusal level (infraocclusion) to reduce the force transmitted to the tooth. The patient was discharged with analgesics and mouthwash.

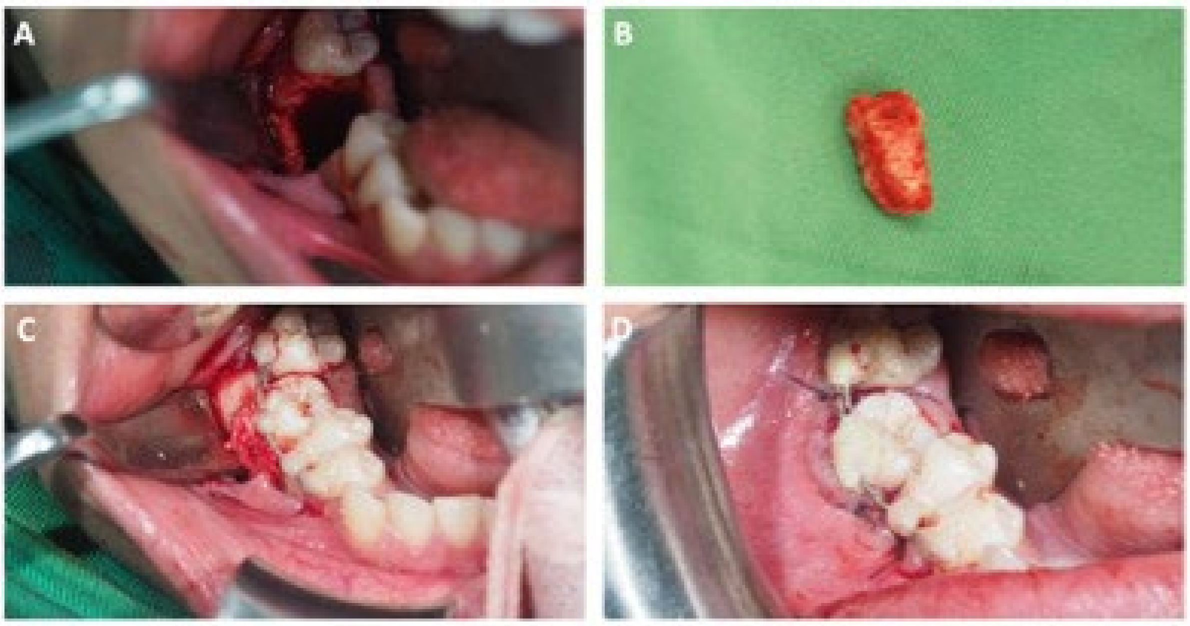

Figure 5. (A) Prepared socket at 46 region. (B) Extracted donor tooth - 48. (C) A splint was placed from 47 to 45 and autograft bone was placed buccally. (D) The flap was reapproximated.

The patient was closely reviewed post-operatively. The splint was removed after two weeks. Following splint removal, the donor tooth was mobile grade I and tender to palpation. The surrounding gingiva appeared healthy and pink in colour. Root canal treatment (RCT) had to be delayed due to COVID-19 issues.

Figure 6. Clinical picture post splint removal.

Figure 7. OPG taken post splint removal.

A single-visit RCT was performed three months later by an endodontist. All three canals were obturated with gutta percha (GP), but there was over-extrusion of GP at the distal and mesial roots. The occurrence was explained to the patient, and an apicectomy was planned should any infection develop in the future.

Figure 8. Post obturation OPG.

During the six-month post-obturation review, the donor tooth was already firm at the recipient site and non-tender to percussion. The surrounding gingiva appeared healthy and pink in colour. An OPG showed increased bone deposition surrounding the roots of the donor tooth with no sign of root resorption.

Figure 9. Clinical picture six months post obturation.

Figure 10. OPG taken 6 months post obturation.

Discussion

One of the advantages of an autotransplanted tooth is bone healing via bone induction. A transplanted tooth with a viable periodontal ligament (PDL) has the capacity to induce and maintain alveolar bone height and width. This is because PDL-resident stem cells are capable of differentiating into fibroblasts, cementoblasts, and osteoblasts. Therefore, these differentiated osteoblasts are more reliable in forming bone around the transplant (Tsukiboshi *et al.*, 2019).

Most clinicians consider autotransplants and implants to be similar procedures since they accomplish comparable goals. While autotransplants are more technique-sensitive and restricted to individuals with adequate donor teeth compared to most implant operations, implants have a wide range of functions and applications without the need for a donor (Mitsuhiro *et al.,* 2019, Mitsuhiro 2002).

However, the applications of implants may require a few considerations and setbacks, especially involving paediatric patients. For example, osseointegrated implants do not have the capability to move or erupt in tandem with adjacent teeth in young patients, resulting in infra occlusion with functional and aesthetic issues (Cross *et al.*, 2013; Tsukiboshi, 2002). Nonetheless, teeth that have been autotransplanted have the ability to erupt, move in unison with neighboring teeth, and seal any remaining gaps between opposing and adjacent teeth (Tatjana *et al.,* 2013, David *et al.*, 2013, Maryam *et al.*, 2012). According to Konstantinia *et al.* (2015), auto-transplanted teeth can also withstand orthodontic movement and permit healthy alveolar bone formation. In an autotransplanted tooth, the PDL regulates alveolar bone development, which contributes to these movements (Mitsuhiro *et al.,* 2019).

In situations where a patient's tooth has a poor prognosis or is congenitally absent, autotransplanted teeth continue to be a preferable option over implants in terms of function, appearance, cost, and time. This is because, even in the presence of a sizable bony defect in the recipient site, the viable PDL promotes quick healing and does not necessitate significant ridge augmentation, bone graft materials, or membranes (Mitsuhiro *et al.,* 2019). According to Tatjana *et al.* (2013), autotransplanted teeth exhibit a natural emergence profile and retain the natural colour and form of the crown and enamel, resulting in superior aesthetic results at a relatively lower cost compared to implants.

In a retrospective study of 614 autotransplanted teeth, it was reported that the cumulative success rate of transplanted teeth with mature roots was 90.1% at 5 years, 70.5% at 10 years, and 55.6% at 15 years. However, the authors also reported that the success rate of implants and fixed partial dentures in 10 years is higher than that of autotransplanted teeth (Yoshino *et al.*, 2012). Hence, multiple factors must be improved to increase the success rate of autotransplant.

The success rate of dental autotransplants is highly dependent on the preservation of the PDL cells on the root surface of the donor tooth, the short extraoral time of donor tooth, and the optimum contact between the recipient bone and the root surface of the transplanted tooth (Kim *et al.*, 2005). In our case, in terms of the preservation of PDL cells, tooth 48 was selected as a donor tooth because it is minimally curved at the apical third compared to tooth 38. Teeth with sharp root curvatures are not ideal candidates for transplantation because there is an increased risk of PDL damage and cemental tear during extraction (Ravi Kumar *et al.*, 2012; Teixeira *et al.*, 2006).

The most crucial factor for the success of autotransplantation is the presence of viable PDL on the root surface, as damaged PDL may cause root resorption or ankylosis regardless of whether the tooth is immature or mature (Chung *et al.*, 2014; Strbac *et al.*, 2016; Tsukiboshi *et al.*, 2019). Based on a systematic review done by Machado *et al.*, (2016) they found that 4% of the autotransplanted teeth became ankylosed and another 4% had root resorption, at which point the PDL was compromised during the procedure. The use of the STL model could prevent unnecessary trial fits of the donor tooth, thereby reducing the risk of damaging the PDL (Shahbazian *et al.*, 2010; Shahbazian *et al.*, 2013).

Extraoral dry time should be minimal as the periodontal ligament cells are very sensitive to osmotic changes (Cross *et al.*, 2013; Jang *et al.*, 2016; Ravi Kumar *et al.*, 2012; Strbac *et al.*, 2016). A study done by Andreasen (1981) showed that the survival ability of PDL was significantly reduced if the extraoral time exceeded 18 minutes. On the other hand, a review done by Cross *et al.* (2013) found that 7% of the autotransplanted teeth developed pulp necrosis at which the extra-alveolar time was less than 1 minute and 20% of the autotransplanted teeth developed pulp necrosis at which the extra-alveolar time was more than 1 minute. In order to reduce extra-alveolar time, the STL model can act as a template instead of the donor tooth itself to prepare the socket (Shahbazian *et al.*, 2012).

A retrospective study done by Kim *et al.*, 2005 showed a better healing rate (87.7%) in cases with good initial stability at the time of the first follow-up as compared to those patients with poor initial stability (72.8%)(Kim *et al.*, 2005). According to Euiseong *et al.* (2005), the initial stability was determined by how well the donor tooth fit into the recipient location without experiencing significant motion. Adaptability between the recipient bone and the root surface of the transplanted tooth is very important as optimal contact with the recipient site can improve the blood supply and the level of nutrition to the periodontal ligament cells (Cross *et al.*, 2013; Jang *et al.*, 2016; Kim *et al.*, 2005). The STL model can help the surgeon prepare the socket as close as possible to the anatomy of the autotransplanted tooth and will provide good initial stability.

With all the benefits of the STL model that have been discussed, it is crucial to decide which materials to use since this affects the precision of the socket size that needs to be prepared. The SLA printer significantly produced the highest precision and trueness of the tooth STL model (Etemad-Shahidi *et al.*, 2020; Németh *et al.*, 2023; Rey-Joly Maura *et al.*, 2021) as it utilizes a laser beam to cure photopolymer material layer by layer.

Even though our patient had RCT treatment late with GP extrusion, the healing progress is still promising, as we believed that we had optimized the preservation of the PDL cells during the surgery. However, longer follow-up is still crucial to monitor the autotransplant tooth.

Conclusion

With the STL model, we were able to minimize injury to the PDL cells of the donor tooth by reducing extraoral time and reducing the number of try-ins of the donor tooth into the recipient socket. We were also able to prepare the recipient socket to have good adaptability with the donor tooth with the use of the STL model. However, longer follow-up is still crucial to monitor the autotransplant tooth.

Acknowledgement

We would like to acknowledge 3D Gens Laboratory for helping us with the STL model fabrication for this case.

Conflict Of Interest

We declare no conflicting interest in this study.

References

Andreasen, J. O. (1981). Periodontal healing after replantation and autotransplantation of incisors in monkeys. *International Journal of Oral Surgery*, 10(1), 54–61. https://doi.org/10.1016/S0300-9785(81)80008-7

Chung, W. C., Tu, Y. K., Lin, Y. H., & Lu, H. K. (2014). Outcomes of autotransplanted teeth with complete root formation: A systematic review and meta-analysis. *Journal of Clinical Periodontology*, 41(4), 412–423. https://doi.org/10.1111/jcpe.12228

Cross, D., El-Angbawi, A., McLaughlin, P., Keightley, A., Brocklebank, L., Whitters, J., *et al.* (2013). Developments in autotransplantation of teeth. *Surgeon*, 11(1), 49–55. https://doi.org/10.1016/j.surge.2012.10.003

Czochrowska, E. M., Stenvik, A., Bjercke, B., & Zachrisson, B. U. (2002). Outcome of tooth transplantation: Survival and success rates 17-41 years posttreatment. *American Journal of Orthodontics and Dentofacial Orthopedics*, 121(2), 110–119. https://doi.org/10.1067/mod.2002.119979

Etemad-Shahidi, Y., Qallandar, O. B., Evenden, J., Alifui-Segbaya, F., & Ahmed, K. E. (2020). Accuracy of 3-dimensionally printed full-arch dental models: A systematic review. *Journal of Clinical Medicine*, 9(10),1–18. https://doi.org/10.3390/jcm9103357

Intra, J. B. G., Roldi, A., Brandão, R. C. B., De Araújo Estrela, C. R., & Estrela, C. (2014). Autogenous premolar transplantation into artificial socket in maxillary lateral incisor site. *Journal of Endodontics*, 40(11), 1885–1890. https://doi.org/10.1016/j.joen.2014.07.008

Jang, Y., Choi, Y. J., Lee, S. J., Roh, B. D., Park, S. H., & Kim, E. (2016). Prognostic factors for clinical outcomes in autotransplantation of teeth with complete root formation: survival analysis for up to 12 years. *Journal of Endodontics*, 42(2), 198–205. https://doi.org/10.1016/j.joen.2015.10.021

Kim, E., Jung, J. Y., Cha, I. H., Kum, K. Y., & Lee, S. J. (2005). Evaluation of the prognosis and causes of failure in 182 cases of autogenous tooth transplantation. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology*, 100(1), 112–119. https://doi.org/10.1016/j.tripleo.2004.09.007

Machado, L. A., do Nascimento, R. R., Ferreira, D. M. T. P., Mattos, C. T., & Vilella, O. V. (2016). Long-term prognosis of tooth autotransplantation: a systematic review and meta-analysis. *International Journal of Oral and Maxillofacial Surgery*, 45(5), 610–617. https://doi.org/10.1016/j.ijom.2015.11.010

Németh, A., Vitai, V., Czumbel, M. L., Szabó, B., Varga, G., Kerémi, B., *et al.* (2023). Clear guidance to select the most accurate technologies for 3D printing dental models – A network meta-analysis☆. Journal of Dentistry,134. https://doi.org/10.1016/j.jdent.2023.104532

Nimčenko, T., Omerca, G., Varinauskas, V., Bramanti, E., Signorino, F., & Cicciù, M. (2013). Tooth auto transplantation as an alternative treatment option: A literature review. *Dental Research Journal*, 10(1), 1–6. https://doi.org/10.4103/1735-3327.111756

Ravi kumar, P., Jyothi, M., Sirisha, K., Racca, K., & Uma, C. (2012). Autotransplantation of mandibular third molar: a case report. *Case Reports in Dentistry*, 2012, 1–5. https://doi.org/10.1155/2012/629180

Rey-Joly Maura, C., Godinho, J., Amorim, M., Pinto, R., Marques, D., & Jardim, L. (2021). Precision and trueness of maxillary crowded models produced by 2 vat photopolymerization 3-dimensional printing techniques. *American Journal of Orthodontics and Dentofacial Orthopedics*, 160(1), 124–131. https://doi.org/10.1016/j.ajodo.2020.06.033

Shahbazian, M., Jacobs, R., Wyatt, J., Denys, D., Lambrichts, I., Vinckier, F., et al. (2013). Validation of the cone beam computed tomography-based stereolithographic surgical guide aiding autotransplantation of teeth: Clinical case-control study. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology*, 115(5), 667–675. https://doi.org/10.1016/j.oooo.2013.01.025

Shahbazian, M., Jacobs, R., Wyatt, J., Willems, G., Pattijn, V., Dhoore, E., *et al.* (2010). Accuracy and surgical feasibility of a CBCT-based stereolithographic surgical guide aiding autotransplantation of teeth: *In vitro* validation. *Journal of Oral Rehabilitation*, 37(11), 854–859. https://doi.org/10.1111/j.1365-2842.2010.02107.x

Shahbazian, M., Wyatt, J., Willems, G., & Jacobs, R. (2012). Clinical application of a stereolithographic tooth replica and surgical guide in tooth autotransplantation: A case study is presented of the use of a stereolithography-fabricated model donor tooth and several guides to facilitate pre-operative planning as well as surgery in the case of tooth auto transplantation in a 10-year-old child. *Virtual and Physical Prototyping*, 7(3), 211–218. https://doi.org/10.1080/17452759.2012.711681

Strbac, G. D., Schnappauf, A., Giannis, K., Bertl, M. H., Moritz, A., & Ulm, C. (2016). Guided autotransplantation of teeth: a novel method using virtually planned 3-dimensional templates. *Journal of Endodontics*, 42(12), 1844–1850. https://doi.org/10.1016/j.joen.2016.08.021

Teixeira, C. S., Pasternak, B., Vansan, L. P., & Sousa-Neto, M. D. (2006). Autogenous transplantation of teeth with complete root formation: Two case reports. *International Endodontic Journal*, 39(12), 977–985. https://doi.org/10.1111/j.1365-2591.2006.01170.x

Tsukiboshi, M. (2002). Autotransplant Success. *Journal Dental Traumatology*, 18(29), 157–180.

Tsukiboshi, M., Yamauchi, N., & Tsukiboshi, Y. (2019). Long-term outcomes of autotransplantation of teeth: A case series. *Dental Traumatology*, 35(6), 358–367. https://doi.org/10.1111/edt.12495

Yoshino, K., Kariya, N., Namura, D., Noji, I., Mitsuhashi, K., Kimura, H., *et al.* (2012). A retrospective survey of autotransplantation of teeth in dental clinics. *Journal of Oral Rehabilitation*, 39(1), 37–43. https://doi.org/10.1111/j.1365-2842.2011.02234.x