BOS

BRITISH ORTHODONTIC SOCIETY

ADVICE SHEET
TOOTH AUTOTRANSPLANTATION

Autotransplantation is extraction of a tooth and the reimplantation of it in a different site in the same patient

When should autotransplantation be considered?

- **Failing or missing tooth/teeth**
  Suitable cases include teeth which are missing or of very poor/hopeless prognosis due to chronic infection or those which are unrestorable due to fracture or ankylosis. This is usually a missing/unrestorable anterior maxillary tooth following dento-alveolar trauma in childhood, but could also be a severely ectopic or developmentally missing tooth. Canines, premolar or third molar teeth have also been used to replace missing teeth (although multi-rooted teeth are generally avoided as donor teeth in the UK).

- **Adolescent patient**
  An osseointegrated implant is contraindicated in the growing patient and fixed prosthodontics are often undesirable if virgin abutment teeth are present. In these patients, an autotransplant is an attractive option. Patients are generally 8-12 years old depending on maturity of donor tooth.

- **Malocclusion with crowding that requires extractions**
  Donor teeth are usually premolars that need to be extracted as part of an orthodontic treatment plan for crowding.

- **Well motivated patient (and parents) with good oral hygiene**

- **No medical contraindications to surgery**

What factors affect the success of autotransplantation?

The following points should be appreciated when considering a transplant[1,2]

- **Inter-disciplinary team**
  An autotransplantation should involve an Orthodontist to plan the extraction pattern, a surgeon with the necessary understanding of the procedure to respect the periodontal ligament during transplantation and a Paediatric/Restorative dentist to monitor healing and undertake the restorative camouflage and endodontic treatment (if required).

- **Recipient site**
  The recipient site should have enough space for the donor tooth, with adequate height and width of bone.

- **Donor tooth root morphology**
  The donor tooth should have a single straight root of simple form to enable an atraumatic extraction; reducing the risk of damage to the periodontal ligament (which would lead to subsequent ankylosis).

- **Donor tooth root development**
  Immature teeth with an open apex have a greater chance of success with the ideal root being half to full root length with a 1mm open apex 3,4,5. This gives a greater chance of maintaining pulpal vitality, whilst ensuring adequate root length is present to support the tooth.

What is a successful autotransplantation?

The success of treatment can be defined by a number of parameters:

- **Periodontal Ligament**
  The aim is to re-establish a vital periodontal ligament between the transplanted tooth and the alveolar bone. This is seen radiographically as a normal continuous lamina dura and clinically as the absence of ankylosis. Signs of ankylosis include reduced mobility or high sound on percussion.

- **Pulp**
  In an immature transplant tooth, there is an excellent chance that pulpal regeneration will occur in the original root canal space. It can be expected that 87% of teeth will show pulpal healing if the apical diameter is greater than 1mm[4]. A vital transplanted tooth will likely show pulp canal obliteration on serial radiographs, with a positive result to electric pulp testing (although tooth vitality is not solely assessed by pulp testing technique)[1,2].

- **Tooth Survival**
  Where there has been damage to the periodontal ligament, ankylosis or replacement resorption will occur and may lead to eventual loss of the tooth if severe[5]. While the tooth is still in situ, it will maintain the anterior aesthetic appearance and the height of alveolar bone in the site for several years and will also act as a space maintainer during the adolescent period.

- **Aesthetic appearance**
  The appearance of a transplanted premolar in the incisor region is generally satisfactory once they have been camouflaged by the restorative team or hidden by an orthodontic appliance.

- **Patient opinion**
  In one study on autotransplantation, patients and parents reported high levels of satisfaction with all aspects of their premolar transplant and their associated orthodontic treatment[6]. Patient-reported outcomes in terms of dental appearance and satisfaction have shown to be good. A study comparing transplanted teeth to their natural contralateral tooth reported that the majority of patients found the appearance to be acceptable[7].

How does the periodontal ligament heal?

The fate of a transplanted or re-implanted tooth is dependent upon the viability of the periodontal ligament attached to the root[1,2]

- **Regeneration**
  The ideal situation is to have vital periodontal ligament (PDL) on the root surface. In this case, there may be complete healing and maintenance of a vital and functioning PDL. The atraumatic extraction of the tooth is paramount to preserve the viability of the PDL and cementum. The cementum forms a protective layer covering the root, into which new PDL can attach. Without it, the root is at risk of resorption by osteoclast cells derived from the bone[1,2]

- **Replacement resorption/ankylosis**
  If the area of necrosis of cementum and PDL are too large, healing will occur by bony replacement with direct contact between the root surface and the adjacent bony socket.

- **Infection related resorption (also known as Inflammatory resorption)**
  This type of resorption occurs when there is both an infected root canal space and adjacent damage to the cementum allowing direct communication via the dentinal tubules to the periodontal ligament space. Inflammatory products from the root canal lead to an inflammatory response at the root surface, driving further resorption of the periodontal ligament and cementum. Unlike replacement resorption, inflammatory resorption can be arrested by promptly instituting root canal therapy and removing the infected pulp. It progresses much more rapidly than replacement resorption, so close follow-up is required to identify and treat it early.

How will the pulp heal?

- **Revascularisation and pulp canal obliteration**
  The pulp of any tooth that is transplanted may suffer ischaemic damage and become necrotic. However, in open apex teeth, the pulp canal space can revascularise by the ingrowth of capillary vessels through the apex. This revascularisation proceeds at 0.5 to 1mm per day 4. Following revascularisation, there is calcification of the pulp canal space with the radiographic appearance of progressive pulp canal obliteration. It should be noted that the tooth still contains vital pulpal tissue and usually gives a positive result to vitality testing.

- **Pulp necrosis**
  Healing of the pulp cannot be expected if the apical foramen of the donor tooth is less than 1mm in diameter and a closed apex donor tooth will always require root canal therapy. This does not preclude the transplantation of teeth with closed apices, although many units avoid this as they have been associated with poorer outcomes. The Leeds Autotransplantation Team no longer transplant mature teeth and solely transplant immature teeth. Pulpal necrosis in an immature tooth provides an endodontic challenge. Historically, apexification was carried out using calcium hydroxide but this has been shown to lead to a weakened root with increased risk of fracture. An alternative is to use mineral trioxide aggregate (MTA) or other calcium silicate cements to form an apical plug (MAP). Other options such as regenerative endodontic treatment (RET) can be considered[8].

What is the prognosis of treatment?

There is limited high level data published on the success of autotransplantation. The largest study looked at 370 transplanted premolar teeth with a mean 5 year follow up. It was reported that 86% showed normal healing, 13.9% were clinically successful but with evidence of root resorption and 0.1% were extracted[3,4,5]. One study showed that teeth transplanted into the area of the upper central and lateral incisor position had a good success rate: 96% of immature donor tooth implants had no complications at 4 years post placement[5].

Key aspects of surgical procedures

- **Pre-operative I extraction of tooth in recipient site**
  For infected recipient site teeth, this should be carried out 4-6 weeks prior to transplant to allow resolution of
  infection in the surgical area. Space should be maintained prior to the transplant.

- **Extraction of the donor tooth**
  No contact can be made with the root surface and so elevators are not used. The tooth is carefully left in its own socket, prior to the preparation of the recipient site.

- **Preparation of the recipient site**
  Surgical drills are used at slow speed with copious irrigation to minimise damage to the bone while creating/enlarging the socket. Socket expanders and condensers can be used to enlarge a socket.

- **Transfer of the tooth**
  The tooth is quickly transferred with minimal extra-alveolar time and minimal trauma to the periodontal
  ligament. The tooth is placed at the same level from the occlusal plane as in the donor site. The transplant historically used to be rotated by 90^{o} but the Leeds transplant team prefer to keep the buccal surface buccally as this generally gives a superior aesthetic result post-restoration.

- **Splinting**
  The tooth is stabilised for 7-10 days using a physiological splint.-

- **Follow-up and risk of inflammatory resorption**
  Transplanted teeth need close follow-up post-operatively due to the risk of inflammatory resorption with clinical and radiographic examination at 7-10 days, 1, 2, 4 and 6 months. Clinical assessment involves vitality testing, assessment of mobility, colour and sound on percussion. In the case of a tooth with a closed apex, root canal

therapy is instituted at 7-10 days (at the same visit as splint remova

Orthodontic movement of transplanted teeth

It has been recommended that a transplanted tooth should be moved following periodontal ligament healing, but before pulpal obliteration and complete healing of the bone. This is at least 3 months post transplantation[9]. > This is based on the guidelines for orthodontic treatment of avulsed teeth[11,12]. Anecdotal evidence from teams in Europe suggests that earlier application of forces, after 8 weeks, can reduce the incidence of transplant ankylosis, but this has not yet been demonstrated by research[13].

Restorative procedures

The preparation of these teeth, e.g. for crowns or to reduce a palatal cusp, should be avoided as this can further damage an already vulnerable and healing pulp which could lead to pulpal necrosis. Simple build ups were historically performed in the short term prior to orthodontic treatment; however, this made accurate tooth repositioning difficult and is best delayed until the transplant is in the correct position. The definitive restoration is then left until after the completion of orthodontics. With a closed apex tooth, as the endodontic therapy is started at 7-10 days following transplantation, tooth preparation can be less conservative.

Conclusion

- Autotransplantation can offer long term definitive treatment for the adolescent patient with missing teeth.
- Advantages include the maintenance of alveolar bone, allowing the tooth to be moved orthodontically, and obviating the need for fixed or removable prosthodontics.
- It is an option long before the placement of an osseointegrated implant could be considered due to the risk of late vertical growth and infra-occlusion of the implant.
- The preservation of a vital periodontal ligament on the root surface is the key to successful autotransplantation.
- The ideal time to transplant a tooth is when the root is immature in order to maximise the chance of revascularisation of the pulp.
- Teeth with closed apices can still be transplanted, but outcomes are less predictable and so closed apex transplants are not carried out as routine. In these cases, root canal treatment is required at 10 days post-transplant.
- Close follow-up is vital to assess and intercept the onset of inflammatory root resorption of the donor tooth.

Reference and further reading

1. Textbook: Tsshi M. Autotransplantation of teeth. Tokyo: Quintessence, 2001
2. Textbook: Andreasen JO, Andreasen FM, Andersson L. Textbook and colour atlas of traumatic injuries to the teeth. Oxford: Blackwell Publishing, 4th Edition 2007.
3. Andreasen JO, Paulsen HU, Yu Z, Ahlquist R, Bayer T, Schwartz O. A long term study of 370 autotransplanted premolars. Part 1, surgical procedures and standardised technique for monitoring healing. EJO. 1990; 12: 3-13
4. Andreasen JO, Paulsen HU, Yu Z, Bayer T, Schwartz O. A longterm study of 370 autotransplanted premolars. Part 2, Tooth survival and pulp healing subsequent to transplantation. EJO. 1990; 12: 14-24
5. Andreasen JO, Paulsen HU, Yu Z, Bayer T, Schwartz O. A longterm study of 370 autotransplanted premolars. Part 3, periodontal healing subsequent to transplantation. EHO. 1990; 12:25-37
6. Shargill I, Nandra S, Day P, Houghton N. Patient and parent satisfaction following Autotransplantation and associated orthodontic treatment delivered by an interdisciplinary team. European Archives of Paediatric Dentistry. 2014; 15(1):27-32

7. Czochowska EM, Stenvik A, Album B, Zachrisson BU. Autotransplation of premolars to replace maxillary incisors: a comparison with natural incisors. Am J Orthod Dentofacial Orthop 2000;118: 592-600

8. Torabinejad M, Nosrat A, Verma P, Udochukwu O. Regenerative Endodontic Treatment or Mineral Trioxide Aggregate Apical Plug in Teeth with Necrotic Pulps and Open Apices: A Systematic Review and Meta-analysis. J Endod 2017; 43(11):18061820

9. Thomas S, Turner SR, Sandy JR. Autotrans-plantation of teeth: Is there a role? BJO 1998 Nov; 25(4): 275-82

10. Czochrowska EM, Stenvik A, Bjercke B, Zachrisson B. Outcome of tooth transplantation: Survival and success rate 17-41 years post treatment. AJODO 2002: 121(2): 110-119

11. Kindelan SA, Day PF, Kindelan JD, Spencer JR, Duggal MS. Dental trauma: an overview of its influence on the management of orthodontic treatment. Part 1. J Orthod 2008; 35: 68-78

12. Andersson L, Andreasen JO, Day P, Heithersay G, Trope M, Diangellis AJ et al., International Association of Dental Trau-matology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. Dent Traumatol 2012; 28 8896

13. Jawad Z, Barber S, Duggal M, Houghton N. Tooth Autotransplantation 2: The interdisciplinary approach with emphasis on the orthodontic aspects. Orthodontic update 2019; 12: 98-105

Produced by the Clinical Governance Directorate of the British Orthodontic Society 2022. Recommendations may change in the light of new evidence.

Administrative Office: The Royal College of Surgeons of England 38-43 Lincoln's Inn Fields London WC2A 3PE
Telephone: 020 7353 8680 Fax: 020 7353 8682 Email: executivesec@bos.org.uk www.bos.org.uk BOS is a Company Limited by Guarantee.
Registered in England & Wales. Company No. 03695486. Registered Charity No. 1073464