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Case Report

The Use of Laser Doppler Flowmetry with Auto Transplanted Teeth

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Abstract:

Dental auto transplantation of teeth, also known as autogenous transplantation, is the movement of one tooth from one position to another within the same person (Hale, 1965). A tooth which is either fully erupted or impacted is positioned into a premade or post extraction socket (Schwartz et al, 1985). It is a procedure, more commonly performed in children, for hypodontia or orthodontic reasons or to replace traumatised or carious teeth.

Key words: hypodontia; orthodontic; autotransplanted teeth

Introduction

Dental auto transplantation of teeth, also known as autogenous transplantation, is the movement of one tooth from one position to another within the same person (Hale, 1965). A tooth which is either fully erupted or impacted is positioned into a premade or post extraction socket (Schwartz et al, 1985). It is a procedure, more commonly performed in children, for hypodontia (as per Figure 1) or orthodontic reasons or to replace traumatised or carious teeth. Placement of a child's natural tooth, unlike implants, will continue to promote alveolar bone development (Pacini et al, 2012). Currently the protocol after transplantation of teeth with closed apices is to prophylactically root treat the teeth to prevent root resorption. However, we are finding that many auto transplanted teeth are maintaining vitality many years post operation and root canal treatment is rarely required as can be seen in Fig 1. We closely monitored patients we had treated at Guy's Hospital (London) in the Oral Surgery department up to 6 years after their operation to monitor the vitality of their transplanted teeth using laser doppler flowmetry (LDF) and see if prophylactic root canal treatment is still a required precaution.

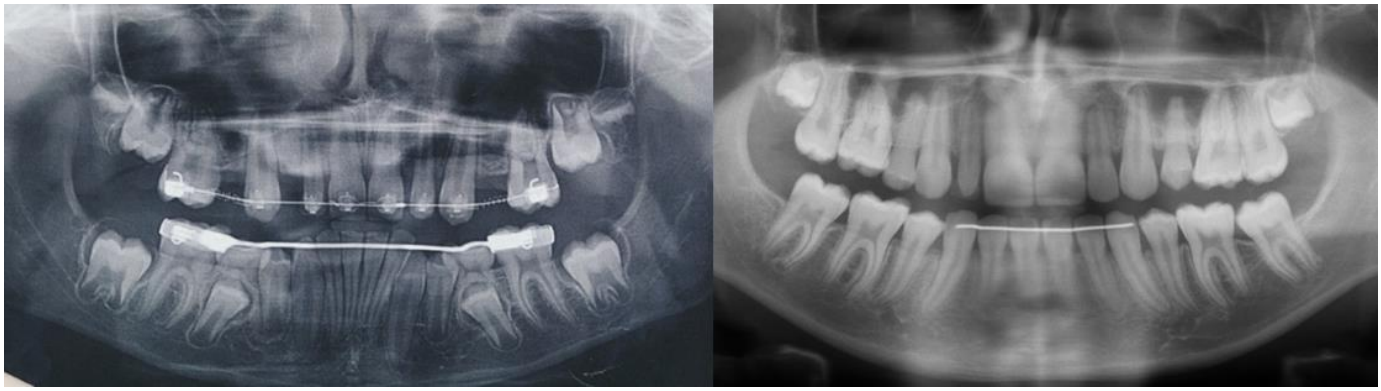

Figure 1: a) OPG prior to autotransplantation of LL4 LR4 into UL4 UR4 spaces and bilateral sinus lift. b) OPG 3 years post autotransplantation

Method

We retrospectively collected details of 15 patients with an overall total of 21 autotransplanted teeth. Pre-operatively we looked at whether the root apices of the transplanted teeth were closed or open, it's position in the arch and the location of the transplantation. We followed these patients up every 3 months over a period of years ranging from 1 to 6. We were closely monitoring whether these teeth maintained a good position and gingival contour, whether they discoloured, underwent resorption, and in the majority of cases tested viascularity using LDF. None of the teeth were root canal treated as a precautionary measure shortly after surgery.

We used a laser doppler flowometry which assesses tooth vascularity by measuring the pulpal blood flow. Laser light emitted by the probe reaches the pulp and is scattered by moving red blood cells. The photons that react with the cells change frequency whereas those reacting with static cells remain unchanged (Jafarzadeh, 2009). The scattered and retuned light is detected by a photodetector (Ghouth et al, 2018). The velocity and concertation of the scattered cells detected creates a flux signal (Ghouth et al, 2018). The higher the number the faster the pulpal flow.

The flux signal of the autotransplanted teeth was measured a minimum of 3 months post-surgery. The probe was placed on the buccal surface of the tooth and an average reading was taken. Regularly a reading was also taken from neighbouring unrestored teeth to use as a comparison.

Results

Overall, we treated 15 patients aged between 13 and 48 years with a mean age of 18.9 years. 21 teeth were autotransplanted and 1 tooth was provisionally parked before being placed in a socket. This is where the tooth is extracted and fixed elsewhere in the oral mucosa before being placed in the final position. 11 of the patients had treatment due to orthodontics, 3 due to hypodontia and 1 due to trauma. 62% of the transplanted teeth were canines, 24% were first premolars and 14% were second premolars.

Pulpal revascularization post transplantation occurs due to ingrowth of newly formed vessels which is essential for tooth survival (Rugani et al, 2023). Sclerosis of the canal and continued root development are indicators of maintained pulp vitality (Kadambari et al, 2022). In our study 17 teeth had closed apices and 4 teeth had open apices by the time of surgery. 100% (n=4) of the teeth with open apices went on to develop closed apices after transplantation indicating successful revascularisation. Two teeth developed sclerosed pulps, both with positive LDF readings.

Overall, 4 teeth (19%) required root canal treatment post-surgery due to external resorption or periapical pathology. All of these teeth had closed apices at transplantation.

All teeth had good gingival contour, did not discolour and maintained good positioning in the arch.

The laser doppler showed positive vascularity results to all the teeth that were tested. Where the flux signal of the adjacent teeth was also measured the readings overall were similar to the transplanted tooth as can be compared in Figure 2. The untransplanted teeth had flux results ranging from 4-15 PU and the transplanted teeth results varied from 4-20 PU. LDF has no standard clinical reference range for dental pulp and studies have shown significant interindividual differences due to tooth morphotype (Cholakova, 2019). Therefore, direct comparison is difficult, however all transplanted teeth had values lying in the expected ranges. Showing that blood flow is maintained with both open and closed apicies.

Tooth transplanted	Months post surgery	Apicies	Flux Transplanted tooth	Untransplanted tooth	Flux Untransplanted tootb	Resoprtion
UR3	54	Closed	4-6	UR1	5-6	No
UL3	54	Closed	8-10	UR4	4-5	No
UR3	3	Closed	7-10	UR2	8-10	No
UL3	7	Closed	5-7	UL2	11-12	No
UL3	15	Closed	7-8			No
UL5	65	Closed				No
UR5	65	Closed				No
LR5	65	Open				No
UR4	6	Closed	10-12	UR5	6-8	No
LL4	8	Closed	6-7			**Yes**
LR4	8	Open	6-7			No
UR3	14	Closed				**Yes**
UL3	48	Closed	8-9			No
UL3	17	Closed	9	UL2	8-10	No
UR3	17	Closed	9-10	UR2	10	No
UL3	4	Closed	9-10	UL2	13.5	No
UR3	9	Closed				No
LL4	73	Open	20			No
LR4	73	Open	10			No
UR3	51	Closed	80			**Yes**
UR3	5	Closed	7-9	UL2	13-15	**Yes**

Figure 2: Table of results comparing the flux readings of the untransplanted tooth with flux reading of the adjacent tooth and if resorption was present.

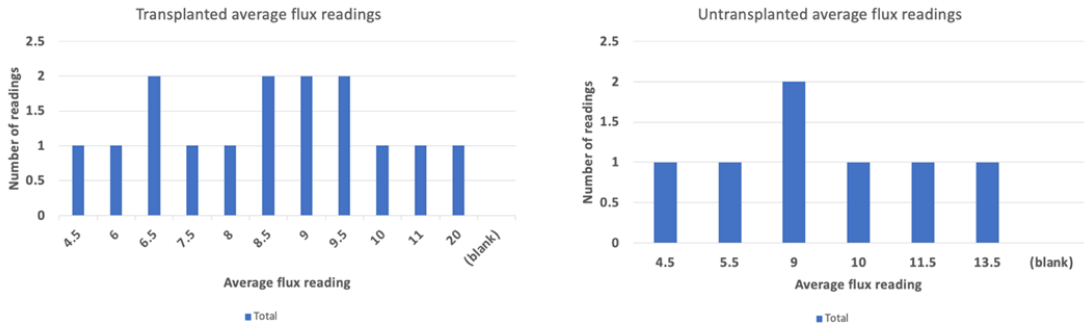

Figure 3: Graphs comparing the flux reading of the transplanted teeth (left) with the untransplanted teeth (right)

Discussion

The results of this study showed that only 19% of the teeth that underwent autotransplantation later went on to have root canal treatment. The teeth that went on to develop resorption had root canal treatment at 5, 8 and 15 months post-surgery and the other at 4 years. All of these teeth had closed apices at the time of transplantation. 3 out of 4 of the cases that required root canal treatment were upper canines that were highly impacted. We suspect that the difficulty in removing these teeth whole and the consequent increased trauma during the procedure reduces their success rate; but there is no evidence for this. The remaining 19 teeth that we continue to monitor have remained vital and healthy as far as 6 years post-surgery. Therefore, we are seeing high success rates of teeth remaining vital post transplantation without resorption and root canal treatment is rarely required.

The strongest diagnostic test for pulpal health is a vitality test; which measures pulpal blood flow. Sensibility testing which stimulates the nerve fibres is not a strong indicator for pulp health. Nerve fibres can remain responsive after pulp necrosis but may also temporarily lose responsiveness after trauma in vital teeth (Jafarzadeh, 2009). It also relies strongly on the patient's interpretation to stimulus and cooperation (Ghouth et al, 2018).

The laser doppler was a useful diagnostic tool for assessing the vitality of the transplanted teeth. Our LDF results matched up with our clinical and radiographical findings. Revascularization is thought to be more successful when teeth have immature apices due to the larger apical diameter. However, our readings show that 88% of transplanted teeth with closed apices also remained vital.

However, the laser doppler is extremely sensitive to the environment and technician technique. Any movement by the technician will ultimately affect the result and any contamination with periodontal blood flow will create a much higher reading. (Jafarzadeh, 2009). Their high cost and technique sensitivity makes them difficult to access in primary care. Patients that have undergone autotransplantation will have continued orthodontic treatment post-surgery. The positioning of the orthodontic brackets on the tooth interferes with placement of the laser doppler probe which may interfere with the readings.

Conclusion

The vast majority of teeth, including those with closed apices, did not undergo resorption post transplantation and maintained pulpal blood flow as far as 6 years post-surgery. From these findings prophylactically root treating these teeth is an unnecessary precaution. These teeth will however require close monitoring with regular radiographs and root treatment should there be any signs of pathology. This saves, what is often a child, prolonged additional dental treatment which requires good patient compliance. Our laser doppler readings show positive results for our transplanted teeth within the expected range but further studies compiling larger patient numbers and standardised clinical ranges for pulpal flux readings would be beneficial.

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