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Clinical Report

Procedures for Treating Spaces Vacated by Loss of Transplanted Teeth

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Abstract

The main reasons for loss of autotransplanted teeth are different from those involved in natural teeth loss. The aim of this study was to investigate which procedures were employed to treat spaces vacated when autotransplanted teeth were lost. Participating dentists were requested to provide information on transplantations they had undertaken. A total of 614 teeth in 552 patients (37 dentists) ranging in age from 17 to 79 years (mean age: 44.1 years) were examined. A total of 102 transplanted teeth were lost during the observation period. Procedures for treatment of spaces vacated were not influenced by main reason for transplanted tooth loss. The procedure used to treat depended on the original prosthodontic treatment of the transplanted teeth. For single crowns, the spaces were left empty (33.9%) or replaced by bridge work (30.5%), implants (20.3%), or dentures (10.2%). For single crowns in the upper and lower second molar regions, the spaces were usually left empty (upper 100%, lower 71.4%), while for those in the upper and lower first molar regions, the spaces were often replaced by bridge work (upper 41.7%, lower 50.0%). For bridge abutments, spaces were replaced by dentures (42.9%), implants (33.3%), or left empty (14.3%), and in the lower second molar region, they were mostly replaced by implants (5 cases, 41.7%). For most denture abutment cases, the spaces were replaced by dentures (88.9%). During the survival period of the transplanted teeth, the masticatory burden on the other teeth is reduced and the adjacent teeth are supported by the transplanted tooth. Even if transplanted

teeth are eventually lost, traditional procedures can be performed to fill the vacated space.

Key words: Autotransplantation of teeth — Lost — Procedure — Dental clinics

Introduction

Since around 1980, a number of studies have reported autotransplantation of teeth with complete root formation[1–4,9,12,14–18]. One study described survival rate in autotransplanted teeth with complete root formation. Watanabe *et al.*[16] reported on 38 autotransplantations in 32 patients, where the mean age at the time of surgery was 24.1 years. More than six years after autotransplantation, 5 teeth were lost. The survival rate was 86.8%, with a mean observation time of 9.2 years. Sugai *et al.*[14] conducted 117 complete root formation transplants on 109 patients ranging from 11 to 75 years in age (mean age, 39.0 years). Of the 117 transplants investigated, 14 (12%) failed during the observation period. The overall 5-year survival rate was 84%. Mejare *et al.*[12] studied 50 patients ranging from 21 to 66 years in age (mean age, 36.7 years) in which a total of 50 third molars with completely developed roots were autotransplanted to replace lost first or second molars in the same number of admitted patients. During a 4-year follow-up period, 7 teeth were lost, so the cumulative survival rate was 81.4%. In our previous study[17], a total of 614 teeth from 552 patients (37 dentists) ranging in age from 17 to 79 years (mean age, 44.1 years) were examined. A total of 102 transplanted teeth were lost, and the survival rate was 90.1% at 5 years and 70.5% at 10 years.

From these reports, it is clear that failure can be expected a number of years after autotransplantation in some cases. The main reasons for loss of autotransplanted teeth are different from those involved in natural teeth loss[13], with attachment loss, root resorption, or root fracture being cited as the cause in the former[2–4,9,12,14–18]. In such cases, a decision must be made as to how to treat the space vacated by the lost tooth. However, to the best of our knowledge, few studies have investigated treatment options in this situation. The aim of this study was to investigate the procedures used to treat the space created when an autotransplanted tooth is lost.

Materials and Methods

Data from our previous report[17] were used for this analysis. Questionnaires were sent to 42 dentists who were members of a clinical research organization called “Kyushikai” and who had performed tooth autotransplantation. A total of 39 dentists responded, providing data on a total of 637 patients and 708 transplanted teeth. Data from two of the dentists (38 patients, 42 teeth) were excluded because the respondents did not include data from all transplantations conducted at their clinics. Data concerning all teeth transplanted during 2010 (47 patients, 52 teeth) were also excluded, as it was not possible to ascertain what kind of prosthodontic treatment was used in these cases. During the observation period, 102 teeth were lost. Therefore, in this study, we examined the procedures used to treat the spaces vacated by these lost teeth.

The distribution of teeth by age group at the time of autotransplantation and at the time of transplanted tooth loss is shown in Table 1. This study examined 102 teeth in 97 patients ranging from 26 to 79 years in age at the time of tooth transplantation (mean age, 57.6 years). The data include 5 cases where 2 teeth were transplanted and lost in the same patient. However, as there was more than a 1-year interval between the loss of these teeth, they were counted as separate cases.

The survival period by recipient site of the teeth examined in this study is shown in

Table 1 Number of teeth by age group at time of autotransplantation and at time of transplanted tooth loss

Age group	Transplantation		Loss	
	n	%	n	%
20–29	6	(5.9)	4	(3.9)
30–39	13	(12.7)	4	(3.9)
40–49	27	(26.5)	20	(19.6)
50–59	24	(23.5)	28	(27.5)
60–69	27	(26.5)	27	(26.5)
70–79	5	(4.9)	19	(18.6)
Total	102	(100)	102	(100)

Table 2 Survival period of transplanted teeth by recipient site

Recipient site / Survival years	Upper				Lower			Total	%
	Premolars		Molars		Premolars	Molars			
	First	Second	First	Second	Second	First	Second		
1–4		2	7	5	3	15	6	38	(37.3)
5–9	3	2	7	2	1	16	13	44	(43.1)
10–14		1	3		3	3	6	16	(15.7)
15–19				1		2	1	4	(3.9)
Total	3	5	17	8	7	36	26	102	(100)

Table 2. Survival period was defined as the number of years from the autotransplantation procedure until the loss of the transplanted tooth.

The main causes of failure were categorized as follows: root resorption, attachment loss, root fracture, caries, or other (including failure of initial healing).

Prosthodontic treatment of the transplanted teeth was categorized as follows: single crown (including resin filling and connecting crowns), abutment of bridge and overdenture. Number of present teeth (PT) was determined after the autotransplantation procedure.

The number of occluding pairs (OPs) was determined by analyzing the dental records of the patients. Any pair of maxillary and mandibular teeth with the same tooth number was counted as one OP; therefore, the maximum of number of OPs in a 32-tooth dentition was 16.

1. Statistical analysis

The patients were divided into 2 groups by age (under 60 years; 60 years or over) and number of PT (under 25; 25 or over), and analysis of the differences between the two groups was performed using the chi-squared test. These cut off points were determined by reference to previous reports[17,18]. A p value of less than 0.05 was regarded as statistically significant. The data was analyzed using the computerized statistical package SPSS, version 15.0 (SPSS Japan, Inc., Tokyo, Japan).

This study was approved by the ethical committee of Tokyo Dental College (Approval Number 269).

Results

The main reasons for tooth loss were as follows: attachment loss in 53 cases (54.1%); root resorption in 26 (26.5%); caries in 4

Table 3 Procedures for treatment of spaces vacated by main reason for transplanted tooth loss (n=98)

Main reason	Denture	Empty	Implant	Bridge work	Tooth transplantation	Total
Attachment loss	22 (41.5)	11 (20.8)	8 (15.1)	10 (18.9)	2 (3.8)	53 (54.1)
Root resorption	7 (26.9)	7 (26.9)	6 (23.1)	6 (23.1)		26 (26.5)
Caries	1 (25.0)	2 (50.0)			1 (25.0)	4 (4.1)
Root fracture			2 (66.7)		1 (33.3)	3 (3.1)
Others	1 (8.3)	3 (25.0)	4 (33.3)	3 (25.0)	1 (8.3)	12 (12.2)
Significant	n.s.	n.s.	n.s.	n.s.	n.s.	

Changing hospital of 4 teeth were excluded in this analysis. The number in parentheses represents a percentage.

Table 4 Mean number of present teeth, occlusal pairs, and age by type of prosthodontic

	Prosthodontic treatment of transplanted teeth (First procedure)			Total
	Single crown	Abutment of bridge	Abutment of denture	
Present teeth	25.9 (±2.9)	22.8 (±3.7)	16.1 (±4.5)	23.5 (±5.0)
Occlusal pairs	11.8 (±2.2)	9.7 (±2.8)	5.0 (±2.4)	10.1 (±3.5)
Age at tooth loss*	54.1 (±12.7)	60.4 (±11.2)	66.4 (±10.2)	57.7 (±12.9)

PT and OPs were counted post-transplantation. *Age at the time of transplanted tooth loss.

(4.1%); root fracture in 3 (3.1%); and other in 12 (12.2%). Procedures for treatment of spaces vacated were not influenced by main reason for transplanted tooth loss (Table 3).

Post-transplantation mean number of PT and OPs by type of prosthodontic treatment are shown in Table 4. Abutment of denture was used in cases where the number of PT and OPs was low, and the age of these patients (at time of transplanted tooth loss) was higher than in those receiving other prosthodontic treatments.

Procedures for treatment of the space vacated by transplanted tooth loss by type of prosthodontic treatment performed after transplantation are shown in Table 5. The treatment of the vacated space depended on the post-transplantation prosthodontic treatment. For single crowns, the spaces were left empty (33.9%) or replaced by bridge work (30.5%), implants (20.3%), or dentures (10.2%). For bridge abutments, the spaces were replaced by dentures (42.9%), implants (33.3%), or left empty (14.3%). For most denture abutments, the spaces were replaced with dentures (88.9%).

Procedures for treatment of the space vacated by transplanted tooth loss by recipient site are also shown in Table 5. For single crowns, spaces in the upper and lower second molar regions were usually left empty (upper 100%, lower 71.4%), and in the upper and lower first molar regions, they were often replaced by bridge work (upper 41.7%, lower 50.0%), implants (upper 25.0%, lower 20.8%), or left empty (upper 25.0%, lower 16.7%). For bridge abutments, the spaces in the lower second molar region were mostly replaced by implants (5 cases, 41.7%). For denture abutments, the spaces were filled with dentures, regardless of recipient site. Nearly all teeth which had been treated with abutment of denture post-transplantation were in patients of over 60 years in age (86.7%), and these spaces were usually filled with dentures (Table 6).

The procedures for filling the spaces are again shown in Table 7, this time by number

Table 5 Procedures for treatment of spaces vacated by transplanted tooth loss by recipient site and post-transplantation prosthodontic treatment (n=98)

Treatment of space vacated by transplanted tooth loss \ Recipient site	Upper				Lower			
	Premolars		Molars		Premolars	Molars		
	First	Second	First	Second	Second	First	Second	Total
Single crown								
Denture		2 (66.7)	1 (8.3)		1 (33.3)	1 (4.2)	1 (7.1)	6 (10.2)
Empty			3 (25.0)	3 (100)		4 (16.7)	10 (71.4)	20 (33.9)
Implant		1 (33.3)	3 (25.0)		2 (66.7)	5 (20.8)	1 (7.1)	12 (20.3)
Bridge work			5 (41.7)			12 (50.0)	1 (7.1)	18 (30.5)
Tooth transplantation						2 (8.3)	1 (7.1)	3 (5.1)
Total		3 (100)	12 (100)	3 (100)	3 (100)	24 (100)	14 (100)	59 (100)
Abutment of bridge								
Denture	1 (100)		1 (100)			3 (60.0)	4 (33.3)	9 (42.9)
Empty						1 (20.0)	2 (16.7)	3 (14.3)
Implant				1 (50.0)		1 (20.0)	5 (41.7)	7 (33.3)
Bridge work							1 (8.3)	1 (4.8)
Tooth transplantation				1 (50.0)				1 (4.8)
Total	1 (100)		1 (100)	2 (100)		5 (100)	12 (100)	21 (100)
Abutment of denture								
Denture	1 (50.0)	2 (100)	3 (75.0)	3 (100)	3 (100)	4 (100)		16 (88.9)
Empty								
Implant	1 (50.0)							1 (5.6)
Bridge work								
Tooth transplantation			1 (25.0)					1 (5.6)
Total	2 (100)	2 (100)	4 (100)	3 (100)	3 (100)	4 (100)		18 (100)

Changing hospital of 4 teeth were excluded in this analysis. The number in parentheses represents a percentage.

Table 6 Procedures for treatment of spaces vacated by transplanted tooth loss by post-transplantation prosthodontic treatment and age

Treatment of space vacated by transplanted tooth loss \ Post-transplantation prosthodontic treatment (First procedure)	Single crown			Abutment of bridge			Abutment of denture		
	Under 60	60 and over	Significant	Under 60	60 and over	Significant	Under 60	60 and over	Significant
Denture	1 (2.6)	5 (25.0)	*	5 (45.5)	4 (40.0)	n.s.	3 (100)	13 (86.7)	n.s.
Empty	15 (38.5)	5 (25.0)	n.s.	1 (9.1)	2 (20.0)	n.s.			—
Implant	6 (15.4)	6 (30.0)	n.s.	4 (36.4)	3 (30.0)	n.s.		1 (6.7)	n.s.
Bridge work	14 (35.9)	4 (20.0)	n.s.		1 (10.0)	n.s.			—
Tooth transplantation	3 (7.7)		n.s.	1 (9.1)		n.s.		1 (6.7)	n.s.
Total	39 (100)	20 (100)		11 (100)	10 (100)		3 (100)	15 (100)	

*$p<0.05$. The number in parentheses represents a percentage.

of PT. For single crowns, implants were used (44.4%), most often in cases of fewer than 25 PT and bridge work (39.0%), or the space was left empty (39.0%) in cases of 25 PT or over. For bridge abutments, implants were used (50.0%) in cases of fewer than 25 PT, and dentures were used (71.4%) in cases of 25 PT or over. For denture abutments,

Table 7 Procedures for treatment of spaces vacated by transplanted tooth loss by post-transplantation prosthodontic treatment and number of PT (n=98)

Treatment of space vacated by transplanted tooth loss \ Post-transplantation prosthodontic treatment (First procedure)	Single crown			Abutment of bridge			Abutment of denture		
	Under 25 PT	25 PT and over	Significant	Under 25 PT	25 PT and over	Significant	Under 25 PT	25 PT and over	Significant
Denture	4 (22.2)	2 (4.9)	n.s.	4 (28.6)	5 (71.4)	n.s.	16 (88.9)		—
Empty	4 (22.2)	16 (39.0)	n.s.	3 (21.4)		n.s.			—
Implant	8 (44.4)	4 (9.8)	*	7 (50.0)		*	1 (5.6)		—
Bridge work	2 (11.1)	16 (39.0)	*		1 (14.3)	n.s.			—
Tooth transplantation		3 (7.3)	n.s.		1 (14.3)	n.s.	1 (5.6)		—
Total	18 (100)	41 (100)		14 (100)	7 (100)		18 (100)		

Number of PT was determined post-transplantation. *$p<0.05$. The number in parentheses represents a percentage.

dentures were used in 88.9% of cases, and dentures were used in most cases of fewer than 25 PT.

Discussion

The decision on what course of treatment to choose when a transplanted tooth is lost is influenced by a number of factors[10]. In this study, the procedures were divided into three groups: single crown, abutment of bridge, and overdenture. Of course, the type of prosthodontic treatment used after transplantation depends on indicators of oral status indicators such as PT and OPs. Abutment of denture is used in cases of severe oral status, which explains why it was used in cases with low number of PT and OPs post-transplantation. The age of the patients was also higher for this procedure than for the other procedures. These factors may influence the treatment chosen to deal with the space vacated by transplanted tooth loss.

When the post-transplantation treatment was a single crown, the selection of how to treat the space vacated by transplanted tooth loss was influenced by the site. In the second molar region, the space was usually left empty. This indicates that the space did not cause a deficiency in masticatory ability. In the first molar region, bridge work was the preferred choice when abutment teeth were available. Implant procedure was selected in cases of fewer than 25 PT, regardless of the patient's age. This was probably because the decreasing number of OPs caused the dentist to decide to increase occlusal support by using fixed prosthodontics.

When the post-transplantation treatment was a bridge abutment, dentures were most commonly used to fill the space, and the second choice was implants. Implants were favored in cases of fewer than 25 PT. Implants tend to be used in patients with lower number of PT because they provide greater stability than dentures[7]. Factors influencing the choice between implant and denture are the wishes of the patient, bone volume, and expenditure. In cases of fewer than 25 PT, we investigated the reason for choice of procedure. Although not reported in the Results section, cost was the reason given by all 4 patients who chose dentures.

A number of studies have reported that a decreasing number of OPs or PT affects the maintenance of a healthy oral environment. Helkimo *et al.*[6] assessed the ability of 139 subjects to grind a given quantity of food within a specific time period. The number of OPs was closely correlated with chewing efficiency, and individuals with fewer than 20 teeth had poorer chewing efficiency than those with more than 20 teeth. Käyser[8] suggested that chewing discomfort begins with fewer than four OPs with symmetrically shortened dental arches (SDA), and six OPs with asymmetric shortening. Leake *et al.*[11]

studied 338 subjects and found that they began expressing masticatory discomfort with zero to two posterior functioning units. Gotfredsen and Walls[5] conducted a review in which they concluded that masticatory efficiency and ability are both linked to the number of teeth. A minimum of 20 teeth with 9–10 pairs of contacting units (including anterior teeth) is associated with adequate masticatory efficiency and ability. Tooth numbers below that level cause impaired masticatory efficiency and are likely to result in a reduction in reported masticatory ability. During their survival period, transplanted teeth ease the masticatory burden on other teeth. Yoshino *et al.*[19] reported on the relationship between number of PT and OPs, finding that the mean number of OPs was 10.4 at 24 PT and 7.2 at 20 PT. These reports and the results of the current study indicate that the cut-off point for deciding between implants and dentures should be around 20 PT.

During the survival period of transplanted teeth, the masticatory burden on the other teeth is reduced and the adjacent teeth are supported by the transplanted tooth. Even if transplanted teeth are eventually lost, traditional procedures can be performed to fill the vacated space.

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