

# Multiple-tooth autotransplantation patients: Long-term (4–8 years) results of treatment

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## SUMMARY

**Background.** Tooth autotransplantation is the surgical movement of a tooth from one region of the mouth to another in the same patient. Mostly, this treatment method is used in patients whose teeth are in the development phase, yet it also constitutes an alternative solution for adult patients.

**Material and methods.** This paper describes a retrospective study of adult patients (aged 18–43y), who had multiple autotransplantations in the period of 2013–2016. The study focuses on cases where at least three teeth needed replacement – a total of 7 patients and 26 instances of autotransplantation. All participants had at least three autotransplantations and at least four years have elapsed since the last transplantation surgery.

**Results.** Autotransplantation viability is 92.3% and rate of success 84.6% for an average monitoring period of 5.6 years (on the 4–8-year period under observation).

**Conclusion.** For missing tooth replacement, the study shows autotransplantation to be a good alternative treatment option to dental implants.

**Keywords:** root resorption, tooth transplantation, third molar, endosseous healing, transplant rejection.

## INTRODUCTION

Autotransplantation may be defined as transferring a tooth that is impacted or has erupted from one oral site to another in the same patient, whether to the extraction site of a recipient tooth or to an alveolus surgically created on the site of a missing one (1-3).

Dental implants have established themselves as the leading treatment for tooth replacement. Still, they are not always available as an option for the patient – in which case autotransplantation can present a good alternative for missing tooth replacement (4-6). In adult patients, autotransplantation tends to be favoured for mainly financial reasons (4). A tooth transplant – even a failed one – still acts as a placeholder for an implant. The use of dental tissue as bone replacement is a growing trend (7).

The surgeon must plan an autotransplantation carefully in order to ensure its long-term

success, considering the condition of the recipient area (5).

The area may be a surgically prepared site or an alveolus created by tooth extraction. To achieve optimum results, the recipient bed must be free of inflammation and infection, and its bone level and thickness on all planes must be sufficient for stabilising the transplanted tooth in the alveolus (8).

Planning the surgery should preferably rely on 3D analysis additionally to other radiographic means (8; 9). Contemporary studies have shown good results using a 'tissue engineering' approach to transplant the tooth into the narrow top ledge of the bone (10). Previously, in cases where the depth of the alveolus was insufficient, alveolus preparation – as well as preparation of the donor tooth – was carried out (11). In a situation where the transplant does not have sufficient mesio-distal space, such space needs to be created by orthodontic treatment prior to surgery (2).

The donor tooth is a tooth – with complete or incomplete root formation – whose dimensions make it suitable for transplantation to the recipient site;

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for best results, it should have completed one half or two thirds of its root formation (12). With donor teeth whose roots are fully formed, root canal treatment must begin at the latest two weeks following transplantation (13). Due to endodontic treatment, such teeth have a higher risk of crown or crown-root fracture.

An aspect that considerably increases the prospects of success for an autotransplant is the presence of viable and undamaged periodontal ligament cells which facilitate recovery and tooth fixation in the alveolus (13). Pulp recovery is only possible if the diameter of the apical aperture exceeds 1 mm (14).

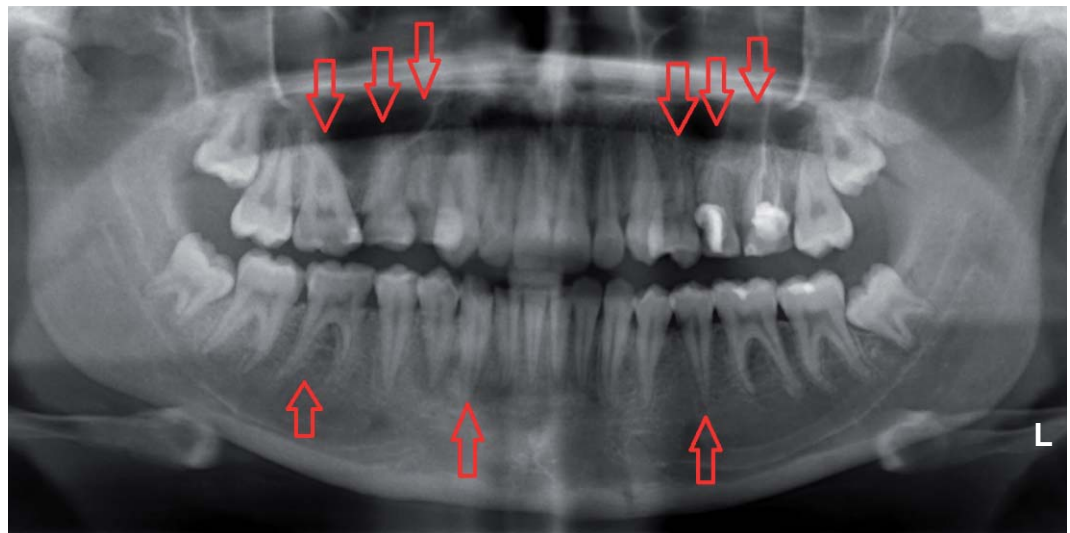
A dense gingival flap can prevent bacterial invasion of gingival pockets and keep tissues surrounding the transplanted tooth from becoming inflamed (15).

A frequent complication encountered on tooth transplantation is root resorption. The trauma caused to the tooth may lead to exterior or surface resorption or to internal resorption (16).

The aim of this study is to investigate the success rate of autotransplantation in adult patients as well as the long-term survival and potential complications of autogenously transplanted teeth.

## MATERIALS AND METHODS

This is a retrospective study based on patients who underwent multiple tooth transplantations during the period from 2013 to 2016. All transplantation procedures were performed by the same surgeon. Patients were selected for the study based on a set of predetermined criteria. One of the requirements was for the patient to have undergone the autotransplantation of at least three teeth. The second requirement stipulated that at least four years must have elapsed after the last transplantation. All patients who were treated during this



**Fig. 1.** Treatment plan of a 18-year-old female who fractured nine teeth due to trauma. The cause of the nine fractured teeth was falling from the 6th floor. She had autotransplantation of six teeth (dd14, 15, 16, 25, 26, 46). Dd14,15 were treated with surgical extrusion, which is one subdivision of the tooth transplantation. These teeth dd14,15 were also rotated in the alveolus 180°. Other fractured teeth (D16, D24/25, D26, D46) were replaced with wisdom teeth, and D43 replaced with implant and D33 treated with filling. All dental transplantations were done in 2014. With red arrows are marked fractured teeth.

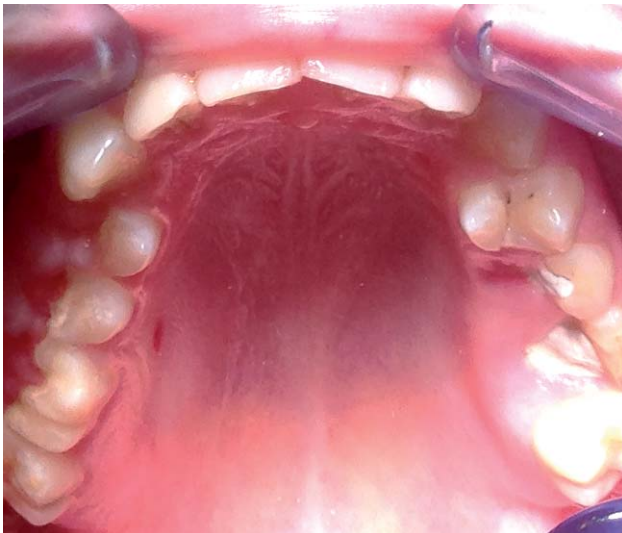
period and fit the specified criteria were included in the study. Sample included a total of seven patients, of whom three were female and four male, and between whom a total of 26 teeth had been autotransplanted.

The aim for the setting of participation criteria was to obtain a better understanding of why, in a specific individual, the procedure may be likely to fail or trigger complications. Similarly, the fact that the patients had had several autotransplantations allowed for comparison of the condition of the transplants. The criteria have been adapted by Schwartz *et al.*, Kristersen, Lagerström and Kugelberg *et al.* (17) and include the absence of progressive root resorption and the presence of normal hard periodontal tissue next to the transplant.

At the time of the surgery, the patients signed a consent form permitting the use of transplanted teeth data in subsequent research. All data used for this study have been anonymised.

The study used information gathered during treatment (entries in the case history, radiological studies and clinical picture). In addition to the operation, the patients came in for follow-up checks which included an orthopantomogram, intraoral photographs and a clinical examination.

The presence of resorption, bone level and changes in surrounding tissues were assessed by radiographic means. Clinical criteria included gingival pocket depth, bleeding when probed, gum recession, tooth mobility and functional occlusal participation.



**Fig. 2.** Preoperative intraoral picture of fractured teeth in upper jaw of the same patient.

Additional aspects to be analysed were donor tooth root development stage, endodontic treatment and the need for alveolus, root and crown preparation during surgery, as well as whether transplantation had been performed immediately following recipient tooth extraction.

Participating patients were also questioned about their general health and about any complaints related to transplanted teeth, and were asked to assess the treatment they had received and its results. These data were used to assess the level of satisfaction with the treatment method.

The analysis of the study's results aims to describe the correlation of specific features of donor tooth anatomy to the success of transplantation and to potential complications. The method used is that of comparison. It was performed using basic logical functions in the MS Excel environment.

## RESULTS

Mostly, the recipient teeth were first molars (60%). Of all donor teeth, 18 (69.2%) had fully

**Table.** Autotransplanted teeth

	Donor	Recipient
Upper incisives	-	-
Upper canin	1	1
Upper premolars	2	5
Upper 1 and 2 molars	1	10
Upper third molar	14	-
Lower incives	-	-
Lower canin	-	-
Lower premolars	-	-
Lower 1 and 2 molar	-	10
Lower third molar	8	-

formed roots and 8 (30.7%) exhibited incomplete root formation (Table). Following tooth autotransplantation, endodontic treatment was performed on 21 teeth (80.7%). With fully formed roots treatment commenced within two weeks following autotransplantation. Also there were 4 teeth with incomplete roots that were treated endodontically due to longer operating time (recipient was out of the mouth more than 5 minutes).

Based on the reported study, the survival rate of adult autotransplanted teeth is 92.3% and success rate 84.6% during an average monitoring period of 5.6 years (on a range of 4 to 8 years).

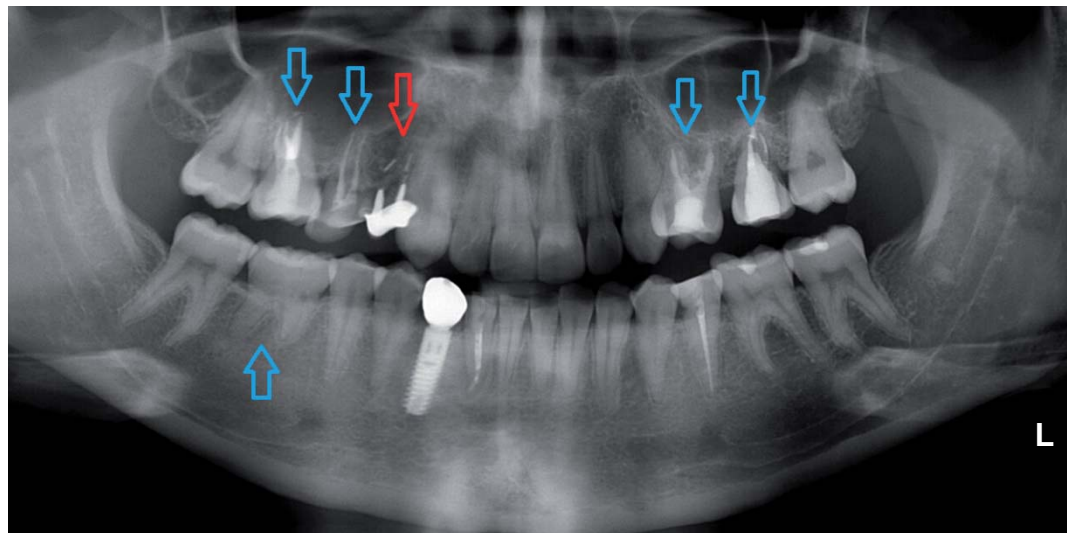
Of the 26 teeth transplanted, 24 were functional at the time of the study and 2 had been extracted by the time the study started. The first of these two 'failure transplant tooth' was extracted 6 months after surgery due to crown fracture in the course of endodontic treatment. The fractured tooth was replaced with a new autotransplanted tooth which to date remains healthy, has not caused any complaints and has a good prognosis. The second 'failure transplant tooth' was extracted six years after transplantation due to progressive root resorption in addition to other symptoms such as increased mobility, deep (>3 mm) gingival pockets and bleeding when probed. At the time of surgery, this tooth had fully formed roots and received root canal treatment following transplantation. Although transplantation was immediate, the surgery was complicated by the root and crown preparation procedures carried out on the donor tooth during the surgery. The surgery was anatomically complicated and extended by the fact that it involved transplanting a maxillary tooth into a mandibular dental ridge.

One case of complicated trauma that has good long-term success is shown in Figures 1-5.

### Results of immediate transplantation

An immediate transplantation into the alveolus of an extracted was carried out with 23 (88.4%) teeth. Three (11.5%) teeth were transplanted to a site from which the tooth had been extracted on an earlier date – i.e., the alveolus for the donor tooth was created surgically during the operation. Even in the immediate-transplantation scenario, alveolus preparation was required in 18 cases (roughly 70% of all recipient alveoli). Donor tooth root preparation was required in 4 (15.3%) out of 26 – mostly cases of delayed transplantation (50%), or those where a maxillary tooth was transplanted to a mandibular alveolus (25%). Nine (34.6%) of the teeth required

crown preparation. By the time the study was conducted, four (15.3%) of the autotransplants represented cases of suspected replacement resorption, and remained infraoccluded. Twenty-two (88.4%) teeth were functional and occluded. None of the other teeth presented any occlusal disorders (for instance, scissor bite or crossbite).



**Fig. 3.** Postoperative OPTG six years after the transplantation operation of the same patient. D14 with root resorption (marked with red arrow). With blue arrows are marked other transplanted teeth which have no complaints and function well. D46 had replaced with wisdom tooth that had unformatted root tip and remained vital after the operation. Others transplants needed root canal treatment.

### Results of delayed transplantation

Delayed transplantation, where the alveolus was created fully by surgical means, was used in only 3 (11.5%) out of 26 teeth. With two of these, root preparation also proved necessary. All three had fully formed roots and all received root canal treatment. All three were properly occluded. Two delayed-transplantation teeth (66.67%) developed resorption. Of these, one had progressive root resorption and was marked for extraction, the other does not present any complications and has a good prognosis. Hence, of three delayed-transplantation teeth, 2 (66.67%) can be deemed a success and 1 (33.3%) a failure.

### Results of transplantation of teeth with fully formed roots

The number of transplanted teeth that had fully formed roots was 18 (69.2%). Of these 18 teeth, 5 (27.7%) developed problems (27.7%). In turn, 2 of these have been extracted (11.1%) and another 2 (11.1%) have a highly adverse prognosis due to progressive root resorption and are to be extracted. In addition to resorption issues, one of the latter also exhibited other problems such as tooth movement, deep gingival pockets (>3 mm), bleeding on probing as well as bone level reduction. The tooth was one of delayed transplantation, and was subject to alveolus and root preparation. The other progressively resorbing tooth only exhibited bleeding on probing. The last of the 5 teeth with post-transplantation problems also exhibited certain signs of resorption (5.6%),

yet its resorption is currently not progressing, the tooth remains asymptomatic and the patient is not reporting any problems – thus, it has been assigned 'to be monitored' status.

Thirteen (72.2%) of 18 teeth that had fully formed roots enjoy an excellent prognosis. Of these 13, 11 (61.1%) are properly occluded; the remaining 2 (11.1%) are infraoccluded but, save for deep gingival pockets (>3 mm) shown by one, exhibit no other complications. Of the 13, 1 (5.6%) bleeds when probed but displays no other complications. One tooth (5.6%) exhibits low bone level and gum recession, but these were diagnosed immediately following transplantation and have remained stable. The transplants with fully formed roots do not exhibit any other complications. All teeth continue to be asymptomatic and the patients have not reported any problems in their respect.

### Results of transplantation of teeth with incomplete root formation

The study involved eight (30.7%) autotransplanted teeth with incompletely formed roots. All such teeth received direct transplantation (immediately following extraction of the recipient). During surgery, alveolus preparation proved necessary in six cases (37.5) and crown preparation was required in a single case (12.5%). All teeth are functioning well and have an excellent prognosis. Seven (87.5%) out of 8 teeth presented no complications at all and the only complication recorded with respect to the remaining one (12.5%) was a deepening of gingival pockets (>3 mm). Root canal treatment proved necessary in four (50%) out of a total of



**Fig. 4.** View of the right side. Six years since teeth autotransplantation of the same patient. There is root resorption of one upper premolar d14 – this one belongs to removal and later replacement with implant. Other transplanted teeth have good prognostic results.

eight transplanted teeth characterised by incomplete root formation. 3 teeth were treated immediately after the operation due to longer operation time (transplanted tooth was out of the mouth more than 5 minutes).

All patients of the study expressed satisfaction with the autotransplantation treatment procedure and its results.

## DISCUSSION

The aim of this study was to assess the success rate of autotransplantation treatment and the long-term viability of autologously transplanted teeth, as well as potential complications that the procedure can give rise to in adult patients.

Previously, high autotransplantation success rates have been linked to the root development stage of the donor tooth, and the procedure was considered to be suited primarily for the treatment of children and juveniles (18). However, in their study, Lucas-Taulé *et al.* concluded that there was no correlation between root tip development stage and the high (91.7% and 97.2% respectively) success and survival rates (19). A study by Ronchetti *et al.* did not find any correlation between success rates and root development stage either. These results suggest a need to revisit the issue of successful autotransplantation of teeth with fully formed roots in adult patients (20).

Based on the results of the study at hand, the survival of autotransplanted teeth during an average observation period of 5.6 years (on a range of 4–8 years) was 92.3% and the success rate 84.6%.



**Fig. 5.** View of the left side. Six years since teeth autotransplantation of the same patient. Transplanted teeth have a good prognostic results.

Similar results (91.1% survival and 78.8% success) have been reported by Czochrowska *et al.* based on a study exclusively of young patients and a relatively low number of teeth, yet with an average observation period that was significantly longer than in other studies (17).

Gonnissen *et al.* obtained the values of 75.3% survival and 57.5% success, which are lower than those previously mentioned and also lower than the values reported in this study. Their study focussed on 73 teeth in patients of widely varying age during an observation period whose average length was 11 years – which may partly account for the significantly lower survival rate (21).

There are many studies obtaining 100% survival and outstanding success during a long observation period (22).

The above differences in results may be caused by differing lengths of the observation period, differing numbers of teeth assessed as well as differences in patients' age and the surgeon's technique. Surgeon's skill and tooth type are factors that have an impact on the success of autotransplantation (20).

In terms of its success and survival rate findings, the results of this study are similar to those of other studies (18), regardless of its shorter observation period. In addition, the study sample includes patients of differing age and comprises a sufficiently large number of transplanted teeth to shed light on factors that pose a risk of possible complications and on correlations between these.

The results obtained by this study allow a series of correlations to be established. Most of

progressively resorbing teeth had, as their donors, mandibular molars with fully formed roots that needed post-operative root canal treatment. It may be suggested that teeth that have fully formed roots and require root canal treatment are exposed to an increased risk of root resorption. Since a tooth whose root development is complete cannot revascularise after transplantation, root canal treatment is obligatory. Such treatment can be complicated due to specific root anatomy, which will have an impact on transplant prognosis. It is likely that the skill of the treating dentist also plays a significant role in the treatment outcome.

Although delayed transplantation with root preparation may be considered a traumatic surgery, this study does not suggest that the tooth concerned should be expected to have a shorter life – one of the two teeth which were transplanted in this study following an interim period and root preparation does not exhibit any problems.

In addition, this study established a correlation between alveolus preparation and post-transplantation reduced bone levels. Of 21 teeth that required alveolus preparation, four exhibit subsequent bone level reduction (the total number of cases of such reduction). Bone level reduction has also been reported in relation to dental implants that were immediately set in post-extraction alveolus but proved unable to prevent the remodelling of bone tissue (23). Reduction of the dimensions of the alveolar ridge following extraction is a natural physiological consequence (24).

In terms of the long-term success rate (84.62%), the results of the study reported here are significant for clinical practitioners.

The most frequently employed method to replace a single missing tooth is that of the dental implant (25). The success rate of replacing a single tooth with a dental implant is decreasing in time (26). One should also consider the fact that implants have their own range of biological and technical issues such as peri-implantitis or mechanical failure (27).

By ensuring proprioceptivity as well as continued bone growth and development, autotransplantation offers significant advantages over implants (28). In addition, it comes at a relatively low cost, which is a reason cited by many patients for preferring it (15).

Since implants are not suitable as a treatment method during the phase of progressive facio-mandibular development (11, 29), and young patients' best option appears to be autotransplantation.

Technically, the extraction of a tooth whose root tips are fully formed is more traumatic for the tooth because the periodontal gap tends to ossify with age in adult patients. Similarly, additional problems were encountered in cases where a mandibular recipient molar was replaced by a maxillary donor whose roots extended asymmetrically outwards and thus, anatomically, required a larger alveolus and caused a reduction in the level of alveolar bone as well as subsequent periodontal problems (increased mobility, deep gingival pockets (>3 mm) and bleeding when probed. Hence, tooth autotransplantation represents an alternative treatment option in certain clinical situations. It allows a tooth to be transplanted from one site to another, and a lost or damaged tooth to be replaced with an autologous donor. Should autotransplantation fail, implantation can be resorted to.

Considering the above, the most preferable treatment method for cases in which autotransplantation has failed is still that of the dental implant (30). The latter is also the treatment that currently enjoys the widest popularity among adult patients requiring tooth replacement (30).

## CONCLUSION

The 92.3% survival and 84.6% success rate found by the study reported above suggests that, autotransplantation treatment remains an option for adult patients, provided the patient has been selected correctly and the surgery has been properly planned.

## STATEMENT OF CONFLICTS OF INTEREST

The author state no conflict of interest. No funding declared.

## ETHICAL APPROVAL

This study was approved by Ethic Committee of Human Research of University of Tartu (protocol No. 340/T-7).

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Received: 21 11 2022  
Accepted for publishing: 25 09 2023