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ORIGINAL ARTICLE

Autotransplantation of maxillary second premolars to mandibular recipient sites where the primary second molars were impacted, predisposes for complications

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Abstract

Objective. The aim of the study was to elucidate whether ankylosis of a transplanted permanent tooth can be predicted based on an evaluation of the primary and permanent dentitions. ***Materials and methods.*** The study comprised 162 maxillary second premolars and 49 third molars transplanted to the mandibular second premolar region in 157 patients treated in the period 1980–2003. Selection criteria: panoramic radiograph available; agenesis of the mandibular permanent premolar/s; persistence of the primary molar at the recipient site. The 211 transplanted teeth were observed for a period of between 1–29 years. ***Results.*** Seven per cent (95% confidence interval, CI = 3–11%) of the transplanted second premolars ankylosed during the first 10 years after operation. The success rate for transplantation of the third molar to the mandibular second premolar region was significantly lower ($p = 0.001$), as 40% (95% CI = 24–57%) of the third molars had ankylosed 10 years after operation. A significant association ($p = 0.022$) was found between ankylosis of a second premolar and infra-position of the primary second molar located at the recipient site. The infraposition group had 13% (CI = 4–23%) ankylosis after 10 year, whereas the non-infraposition group had 5% (CI = 1–9%) ankylosis after 10 years. ***Conclusions.*** The present study concludes that there is an increased risk of ankylosis of the transplanted permanent tooth if the primary tooth at the recipient site is in infraposition. This observation may be decisive for treatment planning, especially in young individuals in whom excessive growth of the alveolar process is expected from the cephalometric analysis.

Key Words: *teeth, transplantation, primary dentition, ankylosis, orthopantomograms*

Introduction

The first reports on successful autotransplantations were published in the 1950s [1,2]. Since then an increasing number of teeth, particularly premolars and canines, have been transplanted and, in 1967, Slagsvold and Bjercke [3] published the first article on autotransplantation of premolars.

The most common indication of autotransplantation of premolars is agenesis of the second mandibular premolar, which has a prevalence of ~ 6% in Denmark [4]. This treatment has proven successful [3,5–8], although cases with complications have been reported [5–8].

It is often the second maxillary premolar that is transplanted to the region of the second mandibular premolar, but small third molars can also be transplanted to this region [9].

It has been concluded that the most optimal time for transplantation is when the tooth has achieved 3/4 root length [6–8,10,11]. It has also been shown that the surgical procedure is important for a successful outcome [3,5–7,10,11].

A successfully transplanted tooth develops a normal root and achieves normal eruption after transplantation [10]. After transplantation the pulp normally undergoes sterile necrosis and then become revascularized. Obliteration of the pulp channel in the root could be observed in all vital teeth, clearly visible after 6 months.

With regards to periodontal healing, Andreasen et al. [7] found normal conditions after 9 weeks in

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Table I. Overview of the dentitions in which transplantation had been performed.

		n	%
Transplanted tooth	Maxillary premolars	162	76.8
	Maxillary and mandibular third molars	49	23.2
Infraposition of primary molar	Infraposition not diagnosed	140	66.4
	Infraposition diagnosed	71	33.6
Ageneses in the dentition	Less than 3 teeth	181	86.2
	More than or equal to 3 teeth	29	13.8
Morphological deviations in the dentition	Not observed	138	65.4
	Observed	63	34.6

the periodontal membrane. Possible root resorption can usually be diagnosed radiographically or clinically 4–8 weeks after transplantation and categorized in surface resorption, inflammatory resorption and resorption before ankylosis [7].

Recent studies have mapped the peri-root tissue layers immunohistochemically. Close to the root a layer rich in innervation was observed. This layer separates the root from a layer with tightly packed fibres, marked by antibody anti-vimentin [12]. This layer is covered by remnants of the Malassez epithelial cells, rich in vascularization [12,13]. This distinct peri-root sheet is suggested to be the layer that has to follow the transplanted tooth to the new position in the jaw.

It is well known that dentitions with ectodermal deviations such as invaginations and taurodontia seem to be particularly exposed to root resorption [14]. It has also been shown that there is a connection between deviant resorption patterns in the primary dentition and a tendency to resorption in the permanent dentition [14,15].

These observations focusing on the inter-relationship between the primary and permanent dentitions form the basis for the hypothesis in the present study.

The hypothesis is that prediction of the developmental course after autotransplantation depends not only on the surgical procedure but also on dental deviations in the permanent and primary dentitions, and specifically that infra-position of primary molars in the recipient region may predict ankylosis of a tooth that is transplanted to the primary molar region.

The purpose of the study was to examine primary and permanent teeth in dentitions where autotransplantation had been performed by the same surgeon and to correlate the transplantation results with the dental findings in order to elucidate if morphological signs in the dentition may predict the transplantation result.

The specific question raised in this study is: Can ankylosis of the transplanted permanent tooth be predicted based on an evaluation of the primary and permanent dentitions?

Materials and methods

The material originated from the archive at the University Hospital, Rigshospitalet, Copenhagen and comprised 162 second premolars and 49 third molars transplanted to the mandibular second premolar region in a total of 157 patients. Overviews of transplanted teeth and dental deviations in the primary and permanent dentitions are given in Tables I and II.

The patients had received treatment in the period 1980–2003 and were selected for the present study based on the following criteria: (1) panoramic radiograph available in the records; (2) agenesis of the mandibular second premolar; and (3) persistence of the primary second molar at the recipient site.

Information from the records

From the records the following information was registered for the material used in the present study: age, gender, identification of the transplanted tooth and region to which the tooth was transplanted. It was also indicated whether the primary tooth in the agenesis region was normally erupted or in infra-position. Infra-position of the primary molars was diagnosed on both panoramic and enoral radiographs. The

Table II. Overview of the transplanted teeth and deviations in the dentitions.

Transplanted teeth	Dentition	*n*	%
Maxillary second premolars	Less than 3 ageneses	142	87.7
	More than or equal to 3 ageneses	20	12.3
	Infraposition not observed	115	71.0
	Infraposition observed	47	29.0
	No other dental deviations observed	100	61.7
	Other dental deviations observed	62	68.3
Maxillary and mandibular third molars	Less than 3 ageneses	39	81.3
	More than or equal to 3 ageneses	9	18.8
	Infraposition not observed	25	51.0
	Infraposition observed	24	49.0
	No other dental deviations observed	38	77.6
	Other dental deviations observed	11	22.4

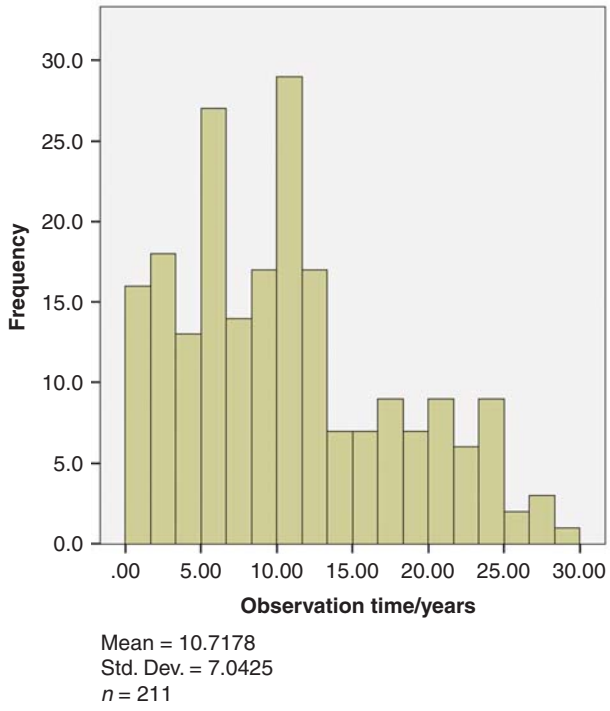

Figure 1. Observation time after transplantation of 211 premolars and third molars.

observation time, presence of ankylosis or pulp necrosis and number of agenesis were registered. Finally, presence of the dental deviations such as taurodontia, invaginations, ectopia, showel-shaped incisors, pointed root shape, gracile roots, root deflections and microdontia was registered.

Surgical procedure

All surgical procedures were performed according to a specific protocol and by the same surgeon (author JOA). The pre-surgical evaluation of the donor tooth included an assessment of the developmental stage of the root according to Moorrees et al. [16]. In cases where the donor tooth had not erupted it was carefully exposed without damaging the follicle. The recipient site was prepared with a surgical drill cooled with sterile saline. All surgical procedures were covered by 5 µ IU penicillin 4-times daily for 4 days.

Post-surgery care

A week after transplantation the first enoral radiograph was taken and after 8 weeks the vertical and horizontal position of the tooth was registered. Furthermore, the mobility, sensitivity and percussion tone of the transplanted tooth were assessed. The depth of the gingival sockets was also registered.

After 8 weeks, 6 and 12 months and after 5 and 10 years the pulp sensitivity was registered. Necrotic pulp was diagnosed when radiologic signs of apical inflammation and/or root resorption and negative response to the sensibility test were observed. Ankylosis was diagnosed on radiographs and by the result of a percussion test.

Statistics

The statistical analyses were performed using the Kaplain-Meier method as implemented in IBM SPSS Statistics version 19.00.

Results

Observation time

The 211 transplanted teeth were observed for a period of between 1–29 years (Figure 1).

Ankylosis

The study showed that 7% (95% CI = 3–11%) of the transplanted second premolars ankylosed during the first 10 years after operation. The success rate for transplantation of the third molar to the mandibular second premolar region was significantly lower ($p = 0.001$), as 40% (95% CI = 24–57%) of the third molars had ankylosed after 10 years. This is illustrated in Figure 2.

A significant association ($p = 0.022$) was found between ankylosis of a second premolar and infra-position of the primary second molar located at the recipient site (Figure 3). The group of primary molars in infraposition at the recipient site had 13% (CI = 4–

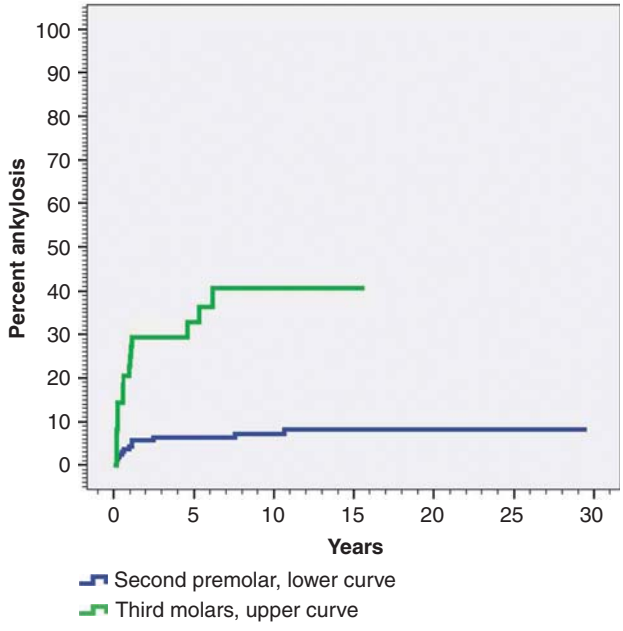

Figure 2. Ankylosis of second maxillary premolars and third molars after autotransplantation to the mandibular second premolar region. The figure demonstrates that 7% of the transplanted second premolars had ankylosis 10 years after transplantation, while 40% of the transplanted third molars had ankylosed 10 years after transplantation.

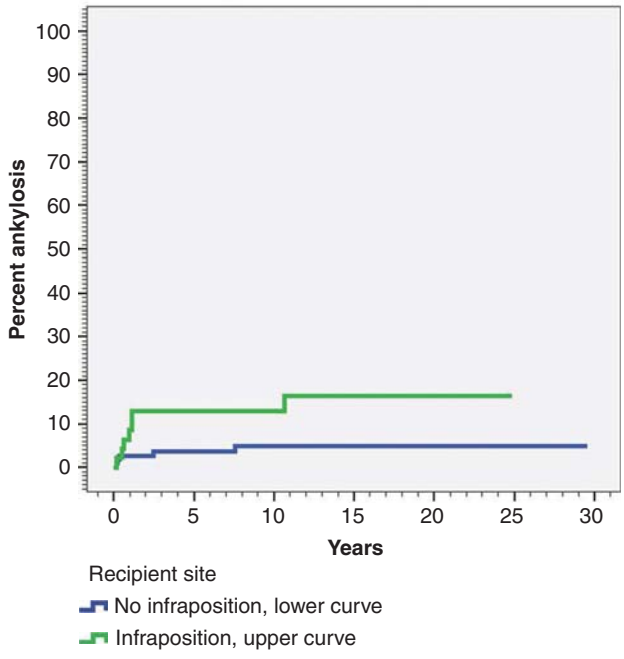

Figure 3. The figure demonstrates that the group of primary molars in infraposition at the recipient site had 13% (CI = 4–23%) ankylosis of second premolars 10 years after transplantation, whereas the group of primary molars not in infraposition at the recipient site had 5% (CI = 1–9%) ankylosis of second premolars 10 years after transplantation.

23%) ankylosis of second premolars 10 years after transplantation, whereas the group of primary molars not in infraposition at the recipient site had 5% (CI = 1–9%) ankylosis of second premolars 10 years after transplantation.

The trend was similar, but no significant association ($p = 0.21$) was found between ankylosis of third molars and infraposition of the primary second molar located at the site to which the third molar was transplanted. The group of primary molars in infraposition at the recipient site had 52% (CI = 30–75%) ankylosis of third molars 10 years after transplantation, whereas the group of primary molars not in infraposition at the recipient site had 25% (CI = 8–43%) ankylosis of third molars 10 years after transplantation. The lack of significance could be explained by the limited number of third molars included in the study (Figure 4).

The inter-relationship between ankylosis of the transplanted tooth and the infra-position of the primary molar at the site to which the tooth was transplanted is demonstrated in Table III.

Other tooth deviations

It was not possible to demonstrate an association between ankylosis after autotransplantation and other dental deviations than infraposition of the primary molar at the recipient site.

Discussion

This study demonstrated an inter-relationship that has not been shown before between ankylosis of a transplanted tooth and infra-position of the primary molar at the recipient site in the jaw. The question is whether this inter-relationship is caused by local conditions at the transplantation site or whether certain factors in the periodontal membrane are responsible for this inter-relationship.

A local factor at the transplantation site could be altered innervation. It is well known that the innervation branch for the canines and premolars in the mandible have a common innervation that terminates at the second premolar region [17]. Furthermore, a previous study by Kjær and Nolting [18] showed a positive reaction prenatally for NGFR (Nerve Growth Factor Receptor) in the alveolar process.

Common factors in the primary and permanent tooth could be deviations in the periodontal tissue layer close to the root. This tissue layer has the same components in primary and permanent teeth [12,19], although with a different representation of the different tissue types, Malassez epithelium, innervation and fibres. This tissue layer may be important for the attachment of Sharpey's fibres to the root surface.

It is possible that a biological deviation in the periodontal ligament in both primary and permanent dentitions increases the risk of ankylosis in both dentitions. It cannot be ruled out if the surgical procedure itself may have influenced the development of ankylosis of the transplanted tooth. This factor may be of lesser importance in this study, where all transplantations were performed by the same surgeon (JOA).

In the present study it was possible to gain an overview of the complete dentition on panoramic

Table III. Inter-relationship between infraposition of the primary tooth at the transplantation site and ankylosis of the transplanted tooth.

Tooth	Statistical method	Chi-square	Significance
Maxillary second premolar	Log Rank (Mantel-Cox)	5.238	0.022*
	Breslow (Generalized Wilcoxon)	5.069	0.024*
	Tarone-Ware	5.168	0.023*
Third molar	Log Rank (Mantel-Cox)	1.562	0.211
	Breslow (Generalized Wilcoxon)	0.0958	0.328
	Tarone-Ware	1.202	0.273

* Indicates significance.

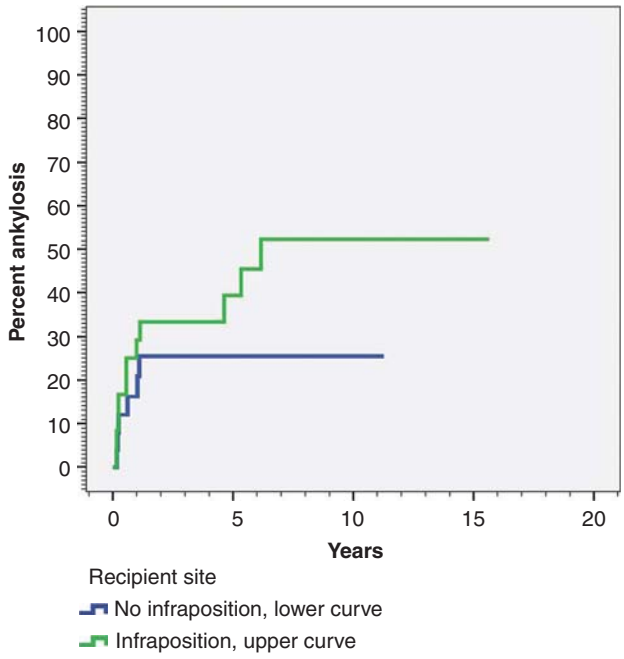

Figure 4. The figure demonstrates that the group of primary molars in infraposition at the recipient site had 52% (CI = 30–75%) ankylosis of third molars 10 years after transplantation, whereas the group of primary molars not in infraposition at the recipient site had 25% (CI = 8–43%) ankylosis of third molars 10 years after transplantation.

radiographs. This overview is highly relevant for diagnostics and treatment planning. An intra-individual association between deviations in the primary and permanent dentitions has also been shown in studies on root resorption [14] and in studies on infraposition of primary molars and malformations of the permanent molars [20].

The main advantage of treating young, growing patients with autotransplantation is that the periodontal membrane regains eruption ability after transplantation and thus contributes to the natural growth of the alveolar process and to occlusal stability during growth.

The present study concludes that there is an increased risk of ankylosis of the transplanted permanent tooth if the primary tooth at the site of transplantation is in infra-position. This observation seems to be important and may be decisive for treatment planning, especially in young individuals in whom excessive growth of the alveolar process is expected cephalometrically after transplantation.

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