


## ORIGINAL ARTICLE

# Effect of implant therapy on oral health-related quality of life (OHIP-49), health status (SF-36), and satisfaction of patients with several agenetic teeth: Prospective cohort study

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## Abstract

**Background:** Effect of fixed prosthodontics on patients with several agenetic teeth is not well understood.

**Purpose:** To assess the effect of implant-based fixed prosthodontics on oral health-related quality of life (OHRQoL), general health status, and satisfaction regarding dental appearance, ability to chew and speech in patients with several agenetic teeth.

**Materials and Methods:** For this prospective cohort study, all patients ( $\geq 18$  years) with several agenetic teeth who were scheduled for treatment with fixed dental implants between September 2013 and July 2015 at our department were approached. Participants received a set of questionnaires before and 1 year after implant placement to assess OHRQoL (OHIP-NL49), general health status (SF-36), and satisfaction regarding dental appearance, ability to chew and speech.

**Results:** About 25 out of 31 eligible patients (10 male, 15 female; median age: 20 [19;23] years; agenetic teeth: 7 [5;10]) were willing to participate. Pre- and post-treatment OHIP-NL49 sum-scores were 38 [28;56] and 17 [7;29], respectively ( $P < .001$ ). Scores of all OHIP-NL49 subdomains decreased, representing an improved OHRQoL ( $P < .05$ ) as well as that satisfaction regarding dental appearance, ability to chew and speech increased ( $P < .001$ ). General health status did not change with implant treatment ( $P > .05$ ).

**Conclusions:** Treatment with implant-based fixed prosthodontics improves OHRQoL and satisfaction with dental appearance, ability to chew and speech, while not affecting general health status.

## KEYWORDS

dental implants, fixed prosthodontics, hypodontia, oral health-related quality of life, patient satisfaction

## 1 | INTRODUCTION

Hypodontia is a condition in which one or more teeth are absent because they failed to develop. In Europe, the prevalence of agenesis

of a tooth is 5.5%, while the prevalence of congenital absence of six or more teeth (excluding the third molars) in Caucasian populations in North America, Australia, and Europe is estimated at 0.14%.<sup>1</sup> Tooth agenesis can be the result of environmental and/or genetic factors and

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can occur as an isolated anomaly or as a feature of a large variety of syndromes (eg, ectodermal dysplasia).<sup>2,3</sup> The etiology of tooth agenesis is complex: more than 200 genes are responsible for tooth development.<sup>4</sup>

Hypodontia is usually noticed between 6 and 12 years of age when deciduous teeth fail to shed or permanent teeth do not emerge. As a result, a variety of problems can become evident such as problems with esthetics, chewing and speech. Hypodontia also affects the oral health-related quality of life (OHRQoL) negatively, as measured with the Child Perceptions questionnaire (CPQ) in children,<sup>5,6</sup> and the Oral Health Impact Profile (OHIP-49) in young adults.<sup>7,8</sup>

A wide range of prosthetic treatment options are available to improve function and dental appearance in hypodontia patients, of which fixed prosthodontics on dental implants is currently the preferred treatment.<sup>9,10</sup> However, the effect of such treatment on patients with more than 4 agenetic teeth (third molars excluded) is not well understood as it has only been assessed in patients with more than 1 agenetic teeth.<sup>11-14</sup> Therefore, the aim of this prospective study was to assess whether treatment with implant-based fixed prosthodontics has a beneficial effect on OHRQoL, general health status, and satisfaction regarding dental appearance, ability to chew and speech in comparison to the pre-implant treatment phase in patients with several agenetic teeth ( $\geq 4$ ; third molars excluded).

## 2 | MATERIALS AND METHODS

### 2.1 | Patient selection

Between September 2013 and July 2015 all patients ( $\geq 18$  years of age) with  $\geq 4$  agenetic teeth (third molars excluded) who were scheduled for treatment with implant-based fixed prosthodontics at the department of Oral and Maxillofacial Surgery, University Medical Center Groningen (The Netherlands), were approached. Informed consent was obtained and the patients received a set of questionnaires 2 months before implant placement. A second set of questionnaires was sent 1 year after implant placement. The Groningen medical ethical committee was approached for permission, but an exemption was granted due to the non-invasive nature of this study (M13.147701).

### 2.2 | Treatment schedule

The routine treatment schedule of hypodontia patients comprised of pre-implant, surgical, and prosthodontic procedures.

#### 2.2.1 | Pre-implant treatment

Orthodontic pre-implant treatment was performed in all our included patients. Such treatment was needed as the interdental diastema are usually too small or too large and the roots are too angulated to allow for implant placement at the preferred positions from a prosthodontic perspective. When needed, the orthodontics were combined with orthognathic surgery prior to implant placement.

#### 2.2.2 | Surgical procedure

All surgical procedures (two-stage) for implant placement were performed under general anesthesia. Implants of Nobel Biocare and Biomet 3i were placed according to the manufacturer's protocol. Bone augmentation, if and when required, was performed simultaneously with the implant placement, unless the patient needs extensive bone augmentation and adequate primary stability of the implant could not be ensured. In that case, augmentation surgery was performed prior to implant placement, and the implants were placed 4 months after augmentation. A surgical guide was always used when placing the implants. After an osseointegration period of 3 months, the implants were uncovered.

#### 2.2.3 | Prosthetic procedure and aftercare

Two weeks after uncovering the implants, surgical aftercare was performed and impressions of the implants were made. The implant-based suprastructures were placed 3 weeks later. Thereafter, orthodontic treatment was finalized when applicable (Table 1). Routine prosthetic aftercare was performed 1 week, 6 months, 1 year, and thereafter every 2 years after suprastructure placement. The number of single crowns and Fixed Dental Prostheses (FDPs) were scored for the included patients.

### 2.3 | Questionnaires

The following set of questionnaires had to be completed 2 months before and 1 year after implant treatment:

#### 2.3.1 | Oral health impact profile

The OHIP-49 is a reliable and valid instrument to measure the social impact of oral disorders.<sup>15</sup> The Dutch version of the OHIP-49 (Dutch OHIP-NL49) was used to measure the OHRQoL.<sup>16</sup> The questionnaire consists of 49 questions and is subdivided into 7 subdomains (1, functional limitation; 2, physical pain; 3, psychological discomfort; 4, physical disability; 5, psychological disability; 6, social disability; and 7, handicap). With each question, the patients were asked how frequently they had experienced the impact of that item in the last month. Answers were given on a 5-point Likert-scale (0, never; 1, hardly ever; 2, occasionally; 3, fairly often; and 4, very often). The total score per subdomain was calculated. Sum-scores range from 0 to 196 where a high score represents a low OHRQoL.

#### 2.3.2 | Healthy survey (SF-36)

The Dutch 36-Item Short Form Healthy Survey (SF-36) is a validated questionnaire with items about a patients' general health status.<sup>17</sup> The SF-36 consists of 36 items of which 35 items are subdivided into 8 health concepts (1, physical functioning; 2, bodily pain; 3, role limitations due to physical health problems; 4, role limitations due to personal or emotional problems; 5, emotional well-being; 6, social functioning; 7, energy/fatigue; and 8, general health perceptions). The other single item addresses changes in health condition. Answer options differ per item but all questions were scored on a 0-100 range. Items in the same scale were averaged to create the 8 scale scores. The lower the score, the more was the disability.

TABLE 1 Participants characteristics

	Participants	Non-responders
Number of patients	25	6
Gender (male;female)	10;15	1;5
Median age at implant placement [IQR]	20.0 [19.0;23.0]	21.5 [19.3;28.3]
General health (number of patients)		
Ectodermal dysplasia	0	0
Cleft	1	0
Congenital heart disease	1	0
Psoriasis	1	0
Asthma	1	1
Epilepsy	0	1
Number of patients with smoking habits		
Non smokers	21	6
Smokers	3	0
Ex-smokers	1	0
Median number of agenetic teeth (third molars excluded) [IQR]	7 [5;10]	7 [7;8]
Number of patients with pre-implant orthodontic treatment	25	6
Number of patients whose orthodontic treatment was completed after implant placement	6	3
Number of patients with pre-implant osteotomy	4	1
Total number of placed implants	148	41
Number lost implants <1 year after placement	3 (in 3 patients)	1
Median number of placed implants per patient [IQR]	5 [4;7]	6 [5;8]
Number of Nobel Biocare implants	88	28
Number of Biomet 3i implants	60	13

### 2.3.3 | Satisfaction-questionnaire

Patients' satisfaction was assessed with a custom-made questionnaire as there are no disease-specific questionnaires available for measuring satisfaction in hypodontia patients. All questions had to be completed on a 10-point scale (score 1 = extremely negative; score 10 = extremely positive). Both the pre- and post-treatment questionnaires assessed how satisfied patients were about their dental appearance, their ability to chew and speech. In addition, the pre-implant treatment questionnaire contained questions about what patients' expected from the effect of the implant-based fixed prosthodontics on their dental appearance, ability to chew and speech. The post-treatment questionnaire, on the other hand, contained one additional question to score whether the implant treatment had satisfied their expectations. The higher the score, the more was the satisfaction.

## 2.4 | Statistics

Pre-implant treatment scores were compared with the post-treatment scores. The Shapiro-Wilk test was used to test the normality of the data ( $P = 0.05$ ). The paired *T*-test was used on the normally distributed data. When the data were not normally distributed, the Wilcoxon signed rank test was applied to test for statistical significance differences (IBM SPSS Statistics 23). The effect size (*r*) was calculated for the statistical significant data, where an *r* of 0.1, 0.3, and 0.5 corresponds with a small, medium, and large effect size, respectively.<sup>18</sup>

## 3 | RESULTS

### 3.1 | Patients

Of the 31 eligible patients, 3 patients did not return the questionnaire because they were not willing to complete the questionnaire. Another 3 patients were not willing to complete the one year evaluation. The baseline demographics of the 6 non-responders did not differ from those of the 25 included patients (Table 1). In these 25 patients, 148 implants were placed and 127 full ceramic suprastructures were made: single crowns ( $n = 109$ ), single crowns with cantilever ( $n = 7$ ), multi-unit FDP ( $n = 8$ ), and multi-unit FDP with cantilever ( $n = 3$ ). All suprastructures were screw-retained.

### 3.2 | Questionnaires

#### 3.2.1 | OHIP-49

The median (IQR) pre- and post-treatment OHIP-NL49 sum-scores were 38 [28;56] and 17 [7;29], respectively (Wilcoxon signed rank test,  $P < .001$ ). The scores of all the subdomains decreased significantly after implant treatment, representing an improved OHRQoL after implant treatment (Wilcoxon signed rank test,  $P < .05$ ; Table 2). The effect sizes (*r*) were medium to large.

#### 3.2.2 | SF-36

The scores of the 8 health concepts, perceived-change-in-health-question and the total SF-36 did not differ significantly between the

**TABLE 2** Oral-health related quality of life (OHRQoL), OHIP-NL49 (median [IQR])

	Pre-implant treatment	One year post-treatment	P value (95%CI)	Effect size (r)
Functional limitation (max. score 36)	8 [7;13]	5 [3;7]	<.001	-0.48
Physical pain (max. score 36)	9 [6;14]	5 [2;8]	<.001	-0.49
Psychological discomfort (max. score 20)	7 [5;11]	2 [0;5]	<.001	-0.48
Physical disability (max. score 36)	6 [4;11]	3 [0;5]	.002	-0.44
Psychological disability (max. score 24)	3 [1;6]	0 [0;3]	.036	-0.30
Social disability (max. score 20)	1 [0;4]	0 [0;2]	.036	-0.30
Handicap (max. score 24)	2 [0;4]	0 [0;1]	.027	-0.31
Sum-score (max. score 196)	38 [28;56]	17 [7;29]	<.001	-0.48

**TABLE 3** Health survey, SF-36 (median [IQR])

	Pre-implant treatment	One year post-treatment	P value (95%CI)
Physical functioning	100 [93;100]	100 [93;100]	.843
Role limitations due to physical health problems	100 [100;100]	100 [100;100]	.443
Role limitation due to personal or emotional problems	100 [67;100]	100 [100;100]	.572
Energy/fatigue	70 [60;80]	65 [60;78]	.603
Emotional well-being	84 [66;86]	84 [68;86]	.987
Social functioning	100 [81;100]	100 [75;100]	.750
Bodily pain	80 [69;95]	90 [84;100]	.500
General health perceptions	75 [70;90]	80 [65;88]	.848
Perceived change in health	50.0 [50;63]	50 [50;75]	.593
Sum-SF36-score	757 [682;793]	754 [651;801]	.957

pre- and post-treatment questionnaires. Thus, no effect of implant treatment on general health status was observed (Wilcoxon signed rank test,  $P > .05$ ; Table 3). This data indicates that the effects of the implant-treatment are notably limited to the oral component.

### 3.2.3 | Satisfaction-questionnaire

The post-treatment scores increased significantly in comparison to the pre-implant treatment scores, hence the patients' satisfaction regarding their dental appearance, chewing and speech ability improved after treatment (Wilcoxon signed rank test,  $P < .001$ ; Table 4). The effect sizes were large.

The patients had high pre-operative expectations regarding the result of the treatment that they were facing, namely the median expectation

scores for the dental appearance, ability to chew, and ability to speak were 9 [8;9], 9 [8;9], and 9 [8;9], respectively. The actual post-treatment scores indicated that these expectations were met (Table 4). Moreover, the patients scored highly on the question "To what extent did your expectations regarding the treatment manifest themselves?" (8 [7;9]).

## 4 | DISCUSSION

This study examined the effect of treatment with implant-based fixed prosthodontics on OHRQoL, general health status, and satisfaction with regard to dental appearance, ability to chew and speech in patients with several agenetic teeth ( $\geq 4$ ; third molars excluded). It was shown that implant treatment had a beneficial effect on OHRQoL and

**TABLE 4** Satisfaction questionnaire (median [IQR])

	Pre-implant treatment	One year post-treatment	P value (95%CI)	Effect size (r)
Opinion about the appearance of the dentition	6 [5;8]	8 [8;9]	<.001	-0.58
Possibility to chew	7 [7;8]	9 [8;10]	<.001	-0.52
Possibility to speak	8 [7;9]	10 [8;10]	<.001	-0.50

patient satisfaction with regard to dental appearance, ability to chew and speech, while no effect of this treatment on the perceived general health status was observed.

As was to be expected, pre-implant treatment OHIP scores were higher for all subdomains compared with the scores reported in the literature for healthy university students with a mean age of 21.2 years.<sup>19</sup> The pre-implant treatment OHIP score will be negatively influenced by the oral discomfort as a consequence of an incomplete dentition. Our pre-implant treatment OHIP scores may have been possibly negatively influenced further by the discomfort the patients experienced as a result of the pre-implant treatment; the questionnaire was completed shortly before implant placement (eg, orthodontic treatment). However, as the OHIP-49 score reported for patients with  $\geq 1$  agenetic teeth (33.5 [24.6;6.0]), who did not receive any treatment at the moment of completing the OHIP-49, was comparable to the OHIP score of our hypodontia patients ( $\geq 4$  agenetic teeth, third molars excluded), we presume that the effect of the pre-implant treatment on the OHRQoL was minor and the OHRQoL was mainly influenced by the discomfort of having hypodontia.<sup>7</sup>

Our patients' post-treatment OHIP-49 scores were generally comparable to those reported for healthy patients,<sup>19</sup> and to the post-treatment OHIP-scores for patients with  $\geq 1$  agenetic teeth (after implant-based and tooth-supported fixed prosthodontics).<sup>11,12</sup> The exception is the Functional Limitation subdomain, which was more limited for both our patients as for the patients with  $\geq 1$  agenetic teeth in comparison to healthy patients.<sup>11,12,19</sup> The remarkable thing about the post-treatment OHIP-question 'Have you had food catching in your teeth or dentures?', which belongs to the subdomain Functional Limitation, is that 22 of the 25 patients gave a  $\geq 1$  score to this question. This might serve as a potential explanation for the higher score of the subdomain Functional Limitation since food gets caught around implants more often in hypodontia because it is difficult to create ideal tissue morphology in areas where the bone quantity is limited.

The SF-36 scores did not show any significant differences between the general health status before and after treatment with implant-based fixed prosthodontics as well as that the scores of our hypodontia patients were comparable to the SF-scores in healthy patients.<sup>19</sup> This is in line with our expectations as we presumed that hypodontia will not have a great impact on general health status, but this was never shown before. Moreover, Allen et al (1999) indicated that the OHIP-49 is of greater use for measuring outcomes of oral disorders than generic measures such as SF-36.<sup>20</sup> This was also our reason to apply both the SF-36 and OHIP-49 in our study. Thus, based on the results of this study, in patients with several agenetic teeth the OHRQoL is influenced by this disorder, but without an impact on their general health.

A limitation of this study was that an applicable and validated satisfaction-questionnaire for hypodontia patients was not available; we had to devise one. The results of our survey revealed that satisfaction regarding dental appearance, ability to chew and speech 1 year after implant placement was very high. These results are in line with the results of Dueled et al (2009) which reported that 98% of the patients with  $\geq 1$  agenetic teeth treated with implant-based fixed

prosthodontics were satisfied to very satisfied.<sup>11</sup> It cannot be excluded, however, that the high satisfaction of our patients when having received their implant-based fixed prosthodontics is, at least to some extent, due to the fact that the patients got rid of the wear temporary solutions and/or orthodontic appliances they had to wear in the period before the placement of the implants.

## 5 | CONCLUSIONS

Implant treatment with implant-based fixed prosthodontics in patients with several agenetic teeth results in an improved OHRQoL and satisfaction regarding dental appearance, ability to chew and speech.

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## ETHICAL APPROVAL

All the procedures performed in the studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

## CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest with the contents of this article.

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