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Onclin, Pieter; Meijer, H. J. A.; Minnen, van, Baucke; Vissink, Arjan; Raghoebar, Gerry

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Retreatment of multiple failing maxillary implants after full arch rehabilitation: a retrospective, observational cohort study

P. Onclin[1], H. J. A. Meijer[1,2], B. van Minnen[1], A. Vissink[1], G. M. Raghoebar[1]
[1]Department of Oral and Maxillofacial Surgery, University Medical Centre Groningen, University of Groningen, Groningen, The Netherlands; [2]Department of Implant Dentistry, University Medical Centre Groningen, University of Groningen, The Netherlands

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Abstract. The aim of this study was to assess implant retreatment in a group of patients whose maxillary implants were all failing after full arch rehabilitation. Treatment involved implant removal, augmentation, and placement of an overdenture supported by four to six implants. All consecutive patients referred between 2008 and 2018, following multiple late implant failures in the rehabilitated maxilla, were included in the study. Seventy implants in 15 patients were evaluated at 3.3 ± 2.5 years (range 1.1–8.6 years) after loading. Implant survival, complications, clinical parameters, marginal bone loss, and patient-related outcome measures were recorded at the time of evaluation. Overall implant survival was 95.7%. Three implant failures occurred within the first year of function. Marginal bone loss was 0.32 ± 0.46 mm; pocket probing depth was 4.55 ± 1.59 mm. Plaque, calculus, inflammation, and bleeding were hardly seen (median index score 0). Patients scored their satisfaction with their overdentures as high (mean overall score 8.7 ± 1.2, maximum 10). Chewing soft and tough food was scored as 'good' and hard food as 'moderate'. The mean Oral Health Impact Profile score was 29.5 ± 33.3. It can be concluded that the replacement of multiple failing implants in an edentulous maxilla after bone augmentation is a safe and predictable treatment procedure when applied as an implant-supported overdenture.

Key words: maxilla; implant; failure; retreatment; edentulous; overdenture.

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Even though implant surgery has become a safe and predictable treatment for replacing teeth[1], peri-implantitis has evolved as a common condition, occurring in 28% to 56% of all patients[2]. Peri-implantitis results in the loss of marginal bone, which can eventually lead to implant loss; this loss is an example of late implant failure, while early implant failure is caused by a lack of osseo-integration[3]. Since a late failure site is exposed to a longer period of infection, this results in a larger amount

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of bone loss and changes in bone quality[4]. Additionally, patients with a late failure tend to show signs of multiple failures[3].

Since there is no fixed prosthetic alternative for most failing implant cases[4,5], retreatment with implants is often considered. Retreatment, however, is associated with lower implant survival because the re-treated sites are still subject to some, if not all, of the previous factors that led to the failure[6]. Maxillary retreatment[7], as well as the retreatment of sites with a lower bone quality and quantity[8], have been shown to result in a lower survival rate. Current research on retreatment is limited to studies describing predominantly early failures with survival rates of between 71.0% and 94.6%[9], while the results of retreatment after late implant failure are sparsely reported. A separate analysis of early and late implant failure in studies incorporating both types of implant failures has, unfortunately, not been performed[7,8,10], and no studies have reported solely cases with a history of late failure sites[11]. Therefore, the purpose of this retrospective study was to assess the outcomes of retreatment in a group of patients with multiple late maxillary implant failures after full arch rehabilitation.

Materials and methods

This retrospective, observational cohort study included all consecutive patients referred to the Department of Oral and Maxillofacial Surgery of the University Medical Centre Groningen, between 2008 and 2018, for late failure of all maxillary implants supporting their fixed dental prosthesis (FDP) or overdenture, who were re-treated. Figure 1 shows an example of one of the patients.

All patients were treated according to the protocol for a new implant-supported maxillary overdenture. Smokers were instructed to cease smoking at least 2 months prior to treatment. Panoramic radiographs were taken at diagnosis, after graft surgery, after implant surgery, and after placement of the new prosthesis. Patients were re-treated by one surgeon (GMR) during two surgical sessions: bone augmentation and implant surgery. In the case of a failed FDP, a temporary removable denture was made prior to implant removal.

During the first session, the implants were removed under general anaesthesia using forceps and implant retrieval tools. Bone grafts were harvested from the anterior iliac crest, calvaria, or retromolar region. A maxillary sinus floor elevation procedure was performed and the bone defects were augmented with particulate bone grafts, as described by Putters et al.[12]. The particulate bone grafts were covered with the corticocancellous bone block, which was fixed with two screws (1.5-mm diameter; KLS Martin, Tuttlingen, Germany; Fig. 1B). The flap was deflected and sutured with resorbable sutures (Vicryl 3–0; Ethicon, Somerville, NJ, USA). Antibiotics (500 mg amoxicillin three times daily for 7 days) and chlorhexidine (twice daily for 14 days) were prescribed. The patients were instructed not to wear their removable maxillary denture for 2 weeks. Thereafter, the denture was adjusted and relined with a resilient material (Reline Extra Soft; GC, Leuven, Belgium).

After a 4-month healing period for the grafted sites, dental implants were placed under general anaesthesia. An epi-alveolar incision was made to reflect a buccal flap. After removing the fixation screws, four to six sandblasted and acid-etched tissue-level implants (Straumann AG, Basel, Switzerland) were placed according to a conventional surgical template. All implants were 4.1 mm in diameter and had a minimum length of 10 mm. After instalment, the flap was deflected and sutured with resorbable sutures. Again, patients were instructed not to wear their dentures for 2 weeks, after which the denture was adjusted and relined with a resilient material. Following 3 months of osseointegration, a bar-retained maxillary overdenture was made.

After completion of the surgical and prosthodontic treatment, the patients were referred back to the referring dentist for routine recalls. The referring dentists were advised to follow our standard aftercare protocol, comprising yearly routine dental check-ups, with the advice to perform annual check-ups and supportive oral hygiene treatment.

The study was approved by the UMCG Medical Ethics Committee (METc 2018/030) and was conducted in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki). Informed consent was obtained from all the participants. The included patients were scheduled for an evaluation visit. Panoramic radiographs were taken, and patient characteristics, treatment characteristics and complications, and clinical parameters were recorded by one observer (PO). Baseline radiographs and additional data concerning complications during treatment were obtained from the patient records.

Outcome measures were implant survival, marginal bone loss (MBL), the presence of plaque, gingival inflammation, bleeding, calculus, probing pocket depth (PPD), and patient-related outcome measures (PROMs). Implant survival was the primary outcome measure. A replacement implant was considered a failure in the event of implant loss, persistent pain, mobility, MBL of >50% of the implant length, or fracture of the implant.

MBL was measured by one blinded observer (HJAM) by comparing the panoramic radiographs taken directly after loading (baseline) with those obtained at the time of the evaluation visit. Implant length was used as a reference when assessing bone loss on the radiographs and was measured between the tip and outer border of the neck of the implant.

Clinical parameters were recorded using standardized indices (at the implant level), including the presence of plaque[13], gingival inflammation[14] and bleeding[13]. Calculus was recorded as absent (0) or present (1). PPD was measured using a periodontal probe (Merritt-B; Hu-Friedy, Chicago, IL, USA), with the deepest pocket being recorded.

PROMs were recorded by asking patients to complete three questionnaires: one regarding chewing efficiency[15], one on overdenture complaints[16], and the Dutch language version of the Oral Health Impact Profile (OHIP-NL49[17]).

Results

Between 2008 and 2018, 16 patients were referred following the complete failure of their maxillary implant-retained FDP or overdenture. All of the implants failed due to severe peri-implantitis. One patient with six implants could not be evaluated because of an invalidating illness during evaluation; this patient was lost to follow-up. Consequently, 15 patients agreed to participate in this retrospective study; five were male and 10 were female, and their mean age was 64 years (range 41–75 years) at the time of surgery. They were followed up for a mean 3.3 years (range 1.1–8.6 years). Table 1 shows the characteristics of the patients.

Surgical complications were limited to perforations of the Schneiderian membrane (Table 2), which were closed with bone blocks and did not interfere in the augmentation procedure. Postoperative complications were limited to wound dehiscence and abscess formation (Table 2). All complications were resolved and had no consequences for further treatment.

Three patients each lost one implant within the first year of function (Table 3), resulting in an implant survival rate

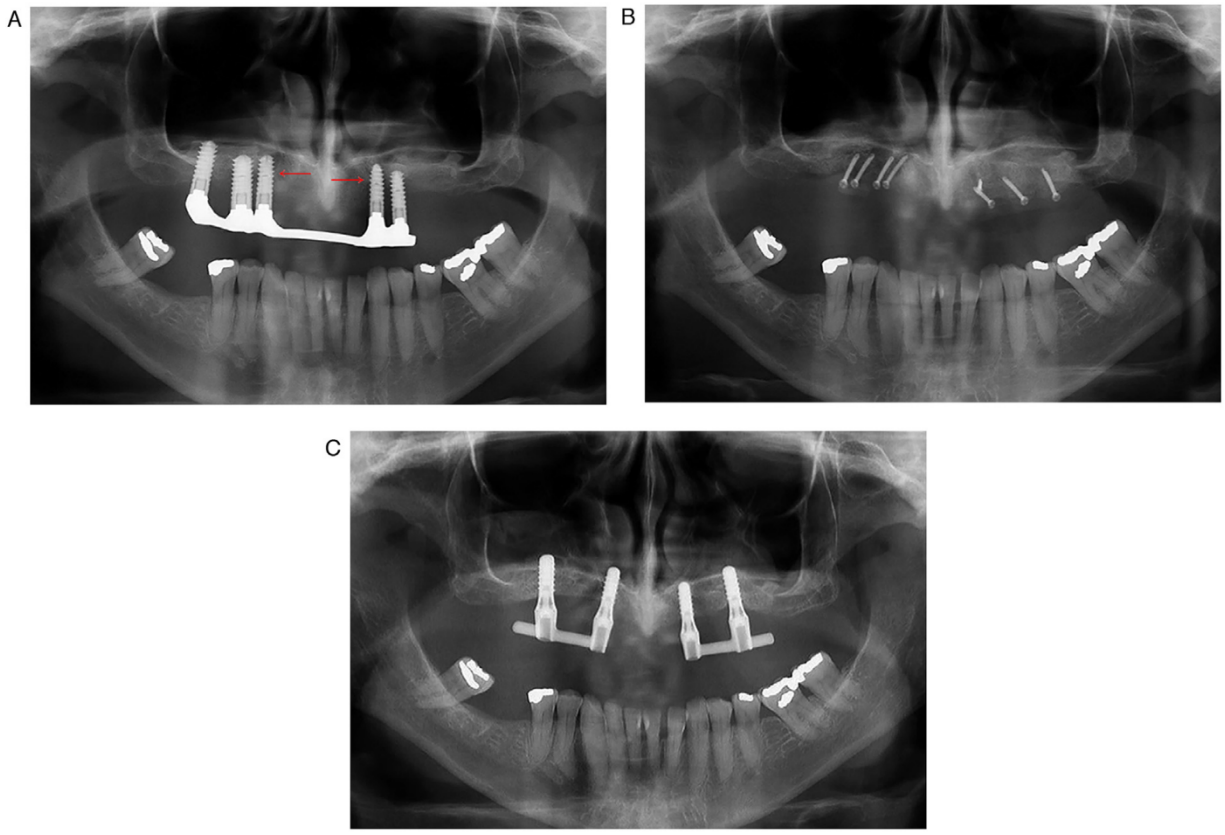

Fig. 1. Panoramic radiographs of one of the patients. (A) Baseline panoramic radiograph showing evident marginal bone loss around the failed maxillary implants (red arrows). (B) Panoramic radiograph after implant removal and bone augmentation. (C) Panoramic radiograph at the time of evaluation (13 months in function).

of 95.7%. Two of those patients were former smokers who had started smoking again after the surgical procedure. The loss of the implants had no prosthetic consequences, and no additional implants had to be placed.

The mean MBL was 0.32 ± 0.46 mm after a mean period of 3.3 years (Table 3). The peri-implant tissues were healthy and the mean PPD was 4.55 ± 1.59 mm (Table 4).

Results of PROMs are given in Table 4. The mean score for overall satisfaction with the maxillary overdenture was 8.7 ± 1.2 (maximum 10). The median scores for eating soft food and tough food were 'good', with scores of 0 (interquartile range (IQR) 0–0) and 0 (IQR 0–0.5), respectively, while for hard food like carrots and apples it was 'moderate' (median 1, IQR 0–1). The mean total OHIP-NL49 score was 29.5 ± 33.3.

Discussion

The aim of this study was to assess implant retreatment in a group of patients with multiple maxillary late failures. Good results were attained at both the clinical and patient level. Complications during augmentation were easily resolved and did not interfere with further treatment. The survival rate was in line with those reported in the most recent publications on replaced implants[4,5,18], while lower rates were seen in the past[6,7,10]. The results indicate that this treatment is a viable option when considering implant retreatment of the edentulous maxilla.

It has been suggested that late failures, i.e. chronically infected sites, such as in the current study, could result in lower bone quality and quantity[4,8], which might lead to a lower survival rate. The current high survival rates contradict this proposition. In this study, the affected sites were augmented and allowed to heal prior to implant retreatment, which is in line with Al Saadi et al.[19], who stated that bone augmentation can assist in a better prognosis.

Re-treated sites are often affected by the same patient-specific factors, such as general health, oral hygiene, and smoking. The patients who lost an implant in this study had adequate oral hygiene and were healthy. Two of the three failed implants were in smokers. Smoking is not yet considered a contraindication for implant surgery[20], but the negative effects appear to be clear[21,22]. Interestingly, all of the failed implants were in patients with an opposing dentition. A review of the literature on this topic yielded conflicting results, but the possible negative effect of an opposing (partial) dentition has been stated[23]. The results of a more recent study on maxillary overdentures with opposing dentitions[24] are comparable to those from edentulous mandibulae[25,26], which contradicts the effect of opposing dentitions and is not in line with the current findings.

In the current study a standardized treatment protocol for treatment of the atrophied maxilla was used, applying autologous bone grafts from the retromolar region, iliac crest, or calvaria. In maxillary sinus floor augmentation surgery, a variety of grafts from different origins may be used. While different graft types may have an impact on healing times, long-term outcomes are comparable for

Table 1. Patient characteristics.

Patient	Age (years)	Sex	General health	Medication	Smoking prior to treatment	Mandibular state	Failed maxillary prosthesis	Previous number of implants	Brand of failed implants	Positions of failed implants
1	66	F	Healthy	Paroxetine, desloratadine	-	Partially dentulous	OD on bar	6	Pitt-easy	16, 14, 13, 23, 24, 26
2	51	F	Anorexia nervosa	Omeprazole, beclamethasone, metamucil, bisacodyl	10/day	OD on bar	OD on ball	4	IMZ	14, 13, 23, 24
3	64	M	Healthy	-	20/day	Partially dentulous	FDP	5	Pitt-easy	16, 22, 25, 26, 27
4	72	M	Hypercholesterolemia	Simvastatin	-	Partially dentulous	FDP	5	Astra	15, 13, 12, 22, 23
5	75	F	Type II diabetes	Metformin, omeprazole, fluvoxamine, diclofenac	-	OD on bar	OD on bar	8	Pitt-easy	16, 14, 13, 12, 21, 23, 24, 26
6	59	F	Lower back hernia	Methadone, diltiazem, pantoprazole,	5/day	OD on bar	OD on bar	5	Astra	16, 14, 12, 21, 23
7	63	F	Healthy	-	-	Partially dentulous	OD on ball	2	Nobel Biocare	13, 23
8	68	F	Osteoporosis	Bisphosphonate	-	OD on bar	OD on bar	6	Pitt-easy	16, 14, 13, 23, 24, 26
9	70	M	Healthy	-	-	Partially dentulous	OD on ball	3	MegaGen	15, 12, 25
10	75	F	Healthy	-	-	Partially dentulous	OD on ball	6	Pitt-easy	15, 14, 12, 22, 24, 25
11	41	F	Healthy	-	-	Conventional denture	OD on ball	6	Biomet 3i	16, 14, 12, 22, 24, 26
12	66	F	Depressed, hypertension	Anti-hypertensive	-	Partially dentulous	FDP	6	MegaGen	15, 13, 11, 21, 23, 25
13	66	M	State after lung carcinoma	Antibiotic (bronchitis)	-	OD on bar	OD on bar	4	Straumann	16, 13, 23, 25
14	52	M	Healthy	-	20/day	Partially dentulous	OD on ball	6	Straumann	16, 14, 12, 22, 24, 26
15	75	F	Migraine, hypertension, heart arrhythmia	Lisinopril, sotalol	-	OD on bar	OD on bar	6	Pitt-easy	16, 14, 12, 22, 24, 26

F, female; M, male; OD, overdenture; FDP, fixed dental prosthesis.

both autologous grafts and bone substitutes[27]. However, in the current specific cases, a large compromised bone defect needed to be restored in both vertical and horizontal dimension. In order to restore these bone defects, autologous onlay bone blocks were used. In addition, research on calvarial bone has shown results comparable to the iliac crest and intraoral sites clinically[12,28–30], histologically[31], and with regard to patient-related outcome measures[12], and the calvaria can be considered a viable alternative to the latter sites, without influencing treatment outcomes. Putters et al.[12] therefore advise a patient-centred decision when considering the donor site.

The evaluated implants showed MBL of 0.32 ± 0.46 mm after a mean evaluation period of 3.3 years, which is comparable to the results of other retreatment studies: Wang et al.[5] reported MBL of 1.7 ± 1.3 mm after a mean of 5.8 years, Kim et al.[7] reported 0.33 ± 0.49 mm after a mean of 1.8 ± 1.2 years, and Quaranta et al.[18] reported 0.60 ± 0.06 mm after 3 years; however, their prosthetic treatments were not the same as those in the current study. The MBL reported by Slot et al.[25], in a study comparing maxillary overdentures supported by four or six implants, was also comparable to the MBL found in the present study (0.58 ± 0.51 mm for four implants and 0.60 ± 0.58 mm for six implants, after 5 years).

The PROMs in the present study were similar to those observed in studies describing regular maxillary overdenture treatment. Slot et al. reported similar overall satisfaction scores after 5 years: 8.6 for four implants and 8.8 for six implants; the mean score in the present study was 8.7 ± 1.2. Boven et al.[32] reported a mean total OHIP-NL49 score of 18.4 ± 17.5 for overdentures supported by four implants after 1 year; considering that the maximum score is 196, this score is a few points lower than the mean score observed in the current study (29.5 ± 33.3). This is quite surprising, since the patients in the present study had gone through a prolonged treatment process when compared to a regular treatment procedure. This indicates that retreatment is a sensible treatment choice from the patient satisfaction viewpoint.

The patients treated in this study received four or six implants. The choice of number was based on the evidence available in the literature at the time of treatment[33]. Therefore, patients with the longest follow-up received six implants, while four implants were placed at a later point in time in comparable

Table 2. Treatment characteristics and complications.

Patient	Implants removed	Augmentation technique	Intraoperative complications	Postoperative oral complications	Postoperative donor site complications	Number of implants placed	Length (mm)	Postoperative implant complications
1	5	SAIB	-	Dehiscence	-	4	10	-
2	3	SAIB	Sinus membrane perforation	Dehiscence	-	6	10/12	-
3	5	SAIB	-	-	-	6	10/12	Early loss of implant (position 13)
4	5	SACB	-	-	-	6	10	Early loss of implant (position 16)
5	8	SACB	Sinus membrane perforation	Dehiscence	-	4	10	-
6	2	SAIB	-	-	Ilium fracture, no dislocation	4	10/12	-
7	2	SAIB	-	-	Temporary hypaesthesia hip region, 5 months	4	10	-
8	6	SAIB	-	-	-	4	10	-
9	3	SAIB	-	-	-	6	14	-
10	6	SAIB	-	-	-	6	10/12	-
11	4	SAIB	-	-	-	4	10	-
12	6	RAIB	Sinus membrane perforation	-	-	4	10	-
13	3	SAIB	-	-	-	4	10	-
14	1	SACB	Sinus membrane perforation	Dehiscence, inflammation, abscess	-	4	10	Early loss of implant (position 13)
15	6	SAIB	-	-	-	4	12	-

SAIB, sinus augmentation with iliac bone; SACB, sinus augmentation with calvarial bone; RAIB, ridge augmentation with intra-oral bone.

patients. Recent systematic reviews on this subject advise a minimum of four implants, but also state that the number of implants in overdenture therapy, as well as the type of anchorage, is still under debate[34,35].

When considering maxillary implant retreatment, a few complications should be taken into account. The close proximity of the failing implants to the maxillary sinus often results in sinus membrane perforation during implant removal. Also, since the infected soft tissues are thin and of inferior quality, tension-free wound closure after augmentation procedures may be challenging and postoperative wound dehiscence often occurs. Large dehiscences can cause sequestra, which might necessitate a second augmentation procedure[36]. In the current study, sinus perforations were closed with bone blocks and small dehiscences were allowed to heal and had no consequences for implant placement.

Most current research describes retreatment of lost implants in general. Since prospective studies might be unrealistic due to the high overall survival rate of implants and the number of participants eligible for such research, future research should focus on reports describing the treatment of patient cohorts with similar circumstances, such as implant retreatment in the anterior or posterior region, maxillary or mandibular region, or dentulous or edentulous situations.

Despite the limitations of this study, it can be concluded that the replacement of multiple failing implants in an edentulous maxilla, after bone augmentation, is a safe and predictable treatment procedure when rehabilitating these patients with a bar-retained overdenture.

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Competing interests

The authors declare no competing interests.

Ethical approval

The study was approved by the UMCG Medical Ethics Committee (METc 2018/030). The principles in the Declaration of Helsinki were followed.

Patient consent

Not required.

Table 3. Implant loss and marginal bone loss (MBL).

Patient	Total implants	Early failure	Late failure	Follow-up (years)	MBL (mm) at follow-up	Mean MBL/year (mm)
1	4	-	-	1.1	0.39	0.36
2	6	-	-	8.6	0.04	0.00
3	6	1	-	7.0	0.47	0.07
4	6	1	-	2.8	0.00	0.00
5	4	-	-	1.2	0.44	0.38
6	4	-	-	1.0	0.60	0.60
7	4	-	-	2.1	0.26	0.12
8	4	-	-	1.3	0.19	0.15
9	6	-	-	6.5	0.00	0.00
10	6	-	-	3.0	0.33	0.11
11	4	-	-	3.8	0.73	0.20
12	4	-	-	2.5	0.97	0.39
13	4	-	-	5.8	0.06	0.01
14	4	1	-	1.7	0.24	0.14
15	4	-	-	1.4	0.37	0.26
Total	70	3 (4.3%)	0	-	-	-
Mean (SD)	-	-	-	3.3 (2.5)	0.32 (0.46)	0.19 (0.18)

SD, standard deviation.

Table 4. Clinical parameters and PROMs.

Clinical parameters	Measure	Result
Plaque index	Median (IQR)	0 (0–0)
Calculus index	Median (IQR)	0 (0–0)
Gingival index	Median (IQR)	0 (0–0)
Bleeding index	Median (IQR)	0 (0–1)
Probing depth, mm	Mean (SD)	4.6 (1.6)
PROMs: Denture complaints		
Functional complaints about lower denture (if applicable)	Mean (SD)	0.3 (0.2)
Functional complaints about upper denture	Mean (SD)	0.2 (0.2)
General functional complaints	Mean (SD)	0.2 (0.1)
Facial aesthetics	Mean (SD)	0.5 (0.8)
Neutral space	Mean (SD)	0.3 (0.5)
Denture aesthetics	Mean (SD)	0.1 (0.2)
Overall satisfaction with mandibular overdenture (if applicable)	Mean (SD)	8.9 (1.4)
Overall satisfaction with maxillary overdenture	Mean (SD)	8.7 (1.2)
PROMs: Chewing ability		
Soft food	Median (IQR)	0 (0–0)
Tough food	Median (IQR)	0 (0–0.5)
Hard food	Median (IQR)	1 (0–1)
PROMs: OHRQOL (OHIP-NL49)		
Functional limitation	Mean (SD)	6.3 (3.9)
Physical pain	Mean (SD)	3.8 (3.0)
Psychological discomfort	Mean (SD)	4.7 (6.9)
Physical disability	Mean (SD)	4.3 (5.6)
Psychological disability	Mean (SD)	4.2 (6.8)
Social disability	Mean (SD)	3.0 (5.8)
Handicap	Mean (SD)	3.1 (5.3)
Total OHIP-NL49 score	Mean (SD)	29.5 (33.3)

IQR, interquartile range; OHIP-NL49, Dutch version of the Oral Health Impact Profile; PROMs, patient-reported outcome measures; SD, standard deviation.

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Address:
Pieter Onclin
Department of Oral and Maxillofacial Surgery
University Medical Centre Groningen
PO Box 30.001
NL-9700 RB Groningen
The Netherlands
Tel.: +31 50 361 1054
E-mail: p.onclin@umcg.nl