# Within-Subject Comparison of Maxillary Implant-Supported Overdentures with and without Palatal Coverage

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## ABSTRACT

*Purpose:* The purpose of this study was to compare patient-reported outcomes for maxillary implant-supported overdentures with and without palatal coverage.

*Materials and Methods:* Twenty-one maxillary edentulous patients (six women, 15 men) were included. In total, 42 implants were inserted in the anterior maxilla. All patients received implant-supported overdentures on two retentive anchors with palatal coverage for 2 months. Thereafter, patient satisfaction was assessed by means of questionnaires capturing the oral health impact profile (OHIP) on functional limitation, physical pain, psychological discomfort, physical, psychological and social disability, and handicap. Additionally, cleaning ability, general satisfaction, speech, comfort, esthetics, stability, and chewing ability were rated. Subsequently, palatal coverage was reduced, and the patients wore the overdentures for another 2 months. Patient satisfaction was obtained in the same way as above, and the evaluated parameters were compared for the two overdenture designs.

*Results:* There were no significant differences between implant-supported overdentures with and without palatal coverage for any of the OHIP domains. The evaluation of additional parameters revealed significantly higher patient satisfaction for esthetics (mean difference 8.8 mm  $\pm$  24.6) and taste (mean difference 28.4 mm  $\pm$  29.9) without palatal coverage, p < .01.

*Conclusions:* Within the limits of this study, maxillary overdentures supported by two implants were equally satisfactory with and without palatal coverage.

**KEY WORDS:** clinical trial, complete, dental implants, dental prosthesis, denture, edentulous, implant-supported, jaw, maxilla, palate, patient satisfaction, quality of life, upper

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## INTRODUCTION

Today, implant-supported overdentures represent a reliable treatment option for both mandible and maxilla.<sup>1–7</sup> However, several systematic reviews and studies concluded that there is a lack of scientific evidence for implant-supported overdentures in the upper jaw with regard to patient satisfaction; implant survival rates; and biological, technical, and prosthetic outcomes.<sup>8–11</sup> Thus, more clinical research is needed, including patient satisfaction on implant-supported maxillary overdentures, both with splinted and unsplinted dental implants.

In order to achieve a satisfying result with a conventional maxillary overdenture, the overdenture design relies on good support and anatomy of the hard palate, together with good adaptation and vestibular seal at the

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borders.<sup>12–14</sup> It has been demonstrated that the tuberosity coverage by the denture is more important for retention than the coverage of the palate.<sup>15</sup> Reduction of the palatal coverage offers several benefits for the patients, including an enhanced taste sensation, better control of the gag reflex, a positive effect on salivary flow rate, and even phonetic benefits.<sup>14,16–19</sup> However, reduction of the palatal coverage might negatively influence the overdenture retention.

A former study evaluated the effects on retention by reducing the palatal coverage of complete maxillary overdentures.<sup>20</sup> The results suggested that the ability to withstand tilting loads was insignificantly altered by reduction of the palatal coverage. In addition, patient responses to interviews indicated that retention also remained unchanged while eating.<sup>20</sup> A further study failed to show significant differences in the effect of palatal coverage in complete overdentures.<sup>21</sup>

Thus, based on these findings, patients seem to be satisfied with conventional overdentures even without palatal coverage, which might function as effectively as the conventional overdenture design.<sup>20,21</sup>

Given that the retention of conventional overdentures is influenced to a greater extent by tuberosity coverage of the overdenture, one might expect that the removal of the palatal coverage in implant-supported overdentures would not impair denture retention significantly.<sup>15</sup> As a result, the need for palatal coverage in implant-supported maxillary overdentures may be questioned.

So far, no significant differences were observed in one study evaluating patient satisfaction for implant overdentures with and without palatal coverage.<sup>2</sup> In that study, four implants were placed, and the overdenture was supported by a bar.<sup>2</sup> There are no scientific data available on the influence of implant support for overdentures with a reduced palatal coverage. The question whether or not there is a difference in patient satisfaction for overdentures with or without palatal coverage supported by a reduced number of implants can therefore not be answered so far.

The hypothesis of the present study was that patient satisfaction is higher for maxillary overdentures supported by two implants without palatal coverage compared to overdentures with palatal coverage.

The aim of the present prospective crossover study was to test whether or not there is a difference in patientreported outcomes for maxillary overdentures supported by two implants with and without palatal coverage.

# MATERIALS AND METHODS

# Study Design and Patients

The present study was a within-subject prospective clinical case series. The study protocol and procedures were approved by the local ethical committee (Medisch Ethische Toetsingscommissie van Vrije Universiteit Medisch Centrum). All patients were informed about the study aim and procedure and gave their written informed consent. Details of the study design and the surgical and prosthetic procedures were reported in a previous publication.<sup>22</sup> In brief, 21 patients experiencing problems with their existing conventional dentures were included in the present study.

# Surgery and Prosthodontics

First, the existing overdentures were either adjusted in terms of rebasing or relining, or new overdentures were made according to proven standards for overdentures.<sup>23</sup> Thus, it was assured that all patients had conventional overdentures fulfilling functional and esthetic criteria. Thereafter, a cone beam computed tomography scan (NewTom 5G, QR, Verona, Italy) was performed for implant planning. Subsequently, two reduced-diameter implants (Roxolid®, 3.3 mm diameter, Institut Straumann AG, Basel, Switzerland) were placed in the anterior maxilla, preferably in the canine area and by means of guided surgery (coDiagnostiX, Dental Wings GmbH, Freiburg, Germany). In case of minor bone defects, local guided bone regeneration (GBR) was applied. In this case, the healing pattern was submerged for 4 months, whereas in all other cases, the healing pattern was transmucosal for 2 months. An impression was taken after the healing period and 1 week after abutment connection for implants with GBR using the overdentures as individual tray. Access holes were prepared for that purpose in the implant area. The overdentures were sent to the lab for conversion to implant-supported overdentures with an incorporated metal frame. The patients wore provisional overdentures during this time, which were duplicates of the conventional overdentures.

Implant-supported upper overdentures were inserted approximately 3 and 5 months after implant placement, depending on the healing pattern. The overdentures were supported by two titanium retentive anchors, which were screwed onto the implants with a defined torque of 35 Ncm (Retentive anchor abutment, Institut Straumann AG). The titanium matrices were already polymerized into the base of the overdentures by the dental technician (Titanium matrix for retentive anchor, Institut Straumann AG). Patient instructions were given concerning handling of the overdentures and oral hygiene specifically for implant overdentures. The occlusion was controlled and corrected in order to be balanced, lingualized, and without anterior contacts in habitual occlusion.<sup>24–26</sup>

#### Patient-Reported Outcomes

All participants measured their satisfaction and perception of the overdentures by responding to questionnaires using visual analogue scales (VAS).<sup>3</sup> The VAS consisted of a 100 mm horizontal line, which was confined at both ends with the below cited anchor words. The patients were asked to draw a vertical line anywhere across the horizontal line, where their perception was best represented. Patient satisfaction was assessed 2 months after insertion of the implant-supported overdentures. The time period of 2 months was previously defined as an adequate time period for patients to adapt and rate new overdentures.<sup>3</sup>

The oral health impact profile (OHIP) for edentulous patients was used to measure patient satisfaction on functional limitation; physical pain; psychological discomfort; physical, psychological, and social disability; and handicap (OHIP-20E). The OHIP questionnaire was in Dutch. The anchor words were "none" (at 0 mm) and "severe" (at 100 mm). Higher scores implied poorer patient satisfaction.

In addition, the questionnaire involved the evaluation of cleaning ability, general satisfaction, speech, comfort, esthetics, stability, chewing ability, function, and taste. The anchor terms for evaluation were "completely satisfied" and "completely dissatisfied." Higher scores meant higher patient satisfaction, with the exception of the evaluation of speech, where higher scores implied decreased patient satisfaction.

At the 8-week follow-up, maxillary overdentures were sent to the lab, and the palatal coverage was reduced by the dental technician as close as possible to the metal frame (Figures 1–3). Thus, the reduction of the palatal coverage was performed in a nonstandardized way, dependent on the dimensions of the metal frame. The patients wore the implant-supported maxillary overdentures without palatal coverage for another 2 months. At the 2-month follow-up, they filled in the questionnaires again (see above). The occlusion was regularly checked. The patients



**Figure 1** Implant-supported maxillary overdenture with marking for the technician where to shorten the palatal coverage.

could thereafter choose which overdenture design they would like to keep (i.e., either with or without palatal coverage). In cases where the patients preferred a closed palate, the overdentures were sent to the lab for closure of the palate with denture acrylic.

## Statistical Analysis

Standard statistics was applied calculating means and standard deviations of patient-reported outcomes for implant-supported overdentures with and without



**Figure 2** Implant-supported maxillary overdenture with reduced palatal coverage, metal frame, and titanium matrices (basal view).



Figure 3 Implant-supported maxillary overdenture with reduced palatal coverage (occlusal view).

palatal coverage. The analysis was performed by means of a statistical software program (SAS® Version 9.2, SAS Institute Inc., Cary, NC, USA).

Before and after treatment measurements were analyzed with the Wilcoxon matched pairs signed rank test (proc univariate). To detect the differences between overdentures with and without palatal coverage, the Wilcoxon Mann-Whitney U test was applied (proc npar1way). For evaluation of the chewing ability, average values of different subgroups were calculated (chewing ability for different types of food). The level of statistical significance was set at 5%.

# RESULTS

## Patients

Physical pain

Physical disability

Social disability

Handicap

Psychological discomfort

Psychological disability

Twenty-one patients (six women, 15 men) with a mean age of 63 years (range 52–81 years) were treated in the

present study. Twelve patients (four women, eight men) were provided with a new pair of conventional overdentures. In the remaining nine patients (two women, seven men), adjustments were made to the existing overdentures by means of relining or rebasing. The patients received in total 42 diameter-reduced implants (Tissue Level Roxolid®, 3.3 mm diameter, Institut Straumann AG, Basel, Switzerland) in the anterior maxilla. A flapless procedure was performed for 36 implants, whereas six implants were placed with simultaneous minor GBR and an open flap procedure. All patients were supplied with maxillary overdentures supported by two retentive anchors (Retentive anchor abutment, Institut Straumann AG). Implants placed without GBR were loaded at 3 months, whereas implants placed with GBR were loaded at 5 months.

The opposing dentitions comprised of mandibular implant-supported overdentures in 17 patients (15 patients with two implants and a bar, one patient with three implants and a bar, and one patient with two implants and retentive anchors), conventional mandibular overdentures in three patients, and three remaining natural teeth and a frame denture in one patient.

# Patient-Reported Outcomes

The mean values of the OHIP domains (in mm) with standard deviations are presented in Table 1 for implant-supported overdentures with (IPp) and without palatal coverage (IPw).

There were no significant differences between the two overdenture designs for any of the OHIP domains (Table 2). Both prosthetic designs were rated highly (i.e., low VAS ratings) with mean VAS ratings for OHIP subgroups ranging from 5.3 to 19.0 mm (Table 1).

9.7

7.9

13.1

7.6

5.3

7.5

13.6

13.7

21.3

12.1

7.9

13.4

TABLE 1 Mean Values and Standard Deviations of All OHIP Subgroups for Implant-Supported Dentures with<br/>Palatal Coverage and without Palatal Coverage. Higher Scores Imply Poorer Patient SatisfactionOHIP SubgroupsIPp MeanIPp SDIPw MeanIPw SDFunctional limitation19.016.216.519.6

15.4

18.1

17.6

19.7

12.8

14.1

12.9

15.5

14.3

12.9

6.8

10.2

OHIP, oral health impact profile; IPp, implant-supported dentures with palatal coverage; IPw, implant-supported dentures without palatal coverage.

TABLE 2 Differences in VAS Values for OHIP Subgroups (Mean Values and Standard Deviations) for Implant-Supported Dentures with Palatal Coverage and without Palatal Coverage. Wilcoxon Matched Pairs Signed Rank Test Was Applied (the Level of Significance Was Set at 5%)

OHIP Subgroups	Mean Difference IPp to IPw	SD of Difference IPp to IPw	Median Difference IPp to IPw	p Value	n
Functional limitation	-3.7	24.1	-6.1	n.s.	17
Physical pain	-4.4	20.9	-2.3	n.s.	18
Psychological discomfort	-4.5	17.0	-0.5	n.s.	18
Physical disability	-1.2	27.4	-1.8	n.s.	18
Psychological disability	-4.6	24.1	-0.1	n.s.	18
Social disability	-1.5	15.0	0	n.s.	18
Handicap	-3.2	11.6	0	n.s.	18

VAS, visual analogue scales; OHIP, oral health impact profile; IPp, implant-supported dentures with palatal coverage; IPw, implant-supported dentures without palatal coverage; n.s., not significant.

The greatest satisfaction (lowest rating) was found for social disability both for implant-supported maxillary overdentures with and without palatal coverage (OHIP IPp  $6.8 \pm 12.8$  mm; IPw  $5.3 \pm 7.9$  mm). The satisfaction was least (highest rating) for functional limitation both for IPp and IPw (OHIP IPp  $19.0 \pm 16.2$  mm; IPw  $16.5 \pm 19.6$  mm).

The evaluation of the VAS scores with concern to general variables (cleaning ability, general satisfaction, ability to speak, comfort, esthetics, stability, chewing ability, function, and taste) revealed significantly higher patient satisfaction for esthetics (mean difference  $8.8 \pm 24.7$  mm) and taste (mean difference  $28.4 \pm 29.9$  mm) with IPw (higher scores) compared with IPp, p < .01 (Tables 3 and 4). There was also a high patient satisfaction for the judgment of general variables with mean VAS scores ranging from 58.5 to 88.6 mm (Table 3).

The highest patient satisfaction was evident for esthetics with IPw (mean  $88.6 \pm 14.9 \text{ mm}$ ), whereas the patients were least satisfied with concern to taste with IPp (mean  $58.5 \pm 23.3 \text{ mm}$ ). Stability for IPp was judged with a mean score of  $69.4 \text{ mm} \pm 35.2 \text{ mm}$  and for IPw with a mean score of  $77.7 \pm 25.2 \text{ mm}$ . All remaining parameters both for IPp and IPw were judged with scores of 70 mm or more, representing a high patient satisfaction. At the end of the evaluation phase (4 months postinsertion of implant dentures), 16 patients chose an open palate, whereas five patients asked for palatal closure.

# DISCUSSION

The present study demonstrated that patient satisfaction does not differ significantly for implant-supported overdentures with or without palatal coverage except for a more positive assumption for esthetics and taste.

Satisfaction							
Variables	IPp Mean	IPp SD	IPw Mean	IPw SD			
Cleaning ability	86.5	13.9	86.7	16.8			
General satisfaction	84.6	21.6	87.8	16.1			
Ability to speak	25.9	33.2	31.1	35.9			
Comfort	71.6	34.6	71.9	35.0			
Esthetics	79.6	28.7	88.6	14.9			
Stability	69.4	35.2	77.7	25.2			
Chewing ability	74.6	19.8	80.0	22.0			
Function	76.6	24.8	84.6	23.8			
Taste	58.5	23.3	86.2	10.3			

TABLE 3 Patient Satisfaction (Mean Values and Standard Deviations) for General Variables of Implant-Supported Dentures with and without Palatal Coverage. Higher Scores Imply Higher Patient Satisfaction

IPp, implant-supported dentures with palatal coverage; IPw, implant-supported dentures without palatal coverage.

Signed Rank Test Was Applied (the Level of Significance Was Set at 5%)									
Variables	Mean Difference IPp to IPw	SD of Difference IPp to IPw	Median Difference IPp to IPw	p Value	n				
Cleaning ability	2.6	18.1	3.1	n.s.	16				
General satisfaction	5.7	26.7	0	n.s.	16				
Ability to speak	2.9	43.1	2.6	n.s.	16				
Comfort	1.0	39.5	4.1	n.s.	16				
Esthetics	8.8	24.7	2.0	< 0.01	16				
Stability	6.2	42.3	0	n.s.	15				
Chewing ability	7.2	24.7	4.3	n.s.	16				
Function	7.1	25.4	6.8	n.s.	17				
Taste	28.4	29.9	21.0	< 0.01	15				

TABLE 4 Differences in VAS Values for General Variables (Mean Values and Standard Deviations) for Implant-Supported Dentures with Palatal Coverage and without Palatal Coverage. Wilcoxon Matched Pairs Signed Rank Test Was Applied (the Level of Significance Was Set at 5%)

VAS, visual analogue scales; IPp, implant-supported dentures with palatal coverage; IPw, implant-supported dentures without palatal coverage; n.s., not significant.

Thus, the hypothesis that patient-reported outcomes are significantly better for maxillary overdentures supported by two implants without palatal coverage could only be partly substantiated.

# **General Satisfaction**

To date, there is no scientific evidence with regard to the optimum number of implants to be placed when treating the edentulous maxilla.<sup>27-29</sup> In the present study, a minimally invasive treatment was chosen with the placement of two anterior implants. The high general patient satisfaction in the present study is in accordance with the results of a systematic review, where the use of two implants in the maxilla did not compromise patient satisfaction.<sup>30</sup> Another study evaluating patient satisfaction with implant-supported overdentures found a high general patient satisfaction independent of the number of implants per denture or attachment type (splinted vs nonsplinted implants).<sup>31</sup> Despite speculations that implant survival or patient satisfaction may not be compromised with the use of two implants to support maxillary overdentures, this treatment option is still not supported by the literature today.<sup>32,33</sup>

The patients in the present study completed questionnaires after wearing overdentures with and without palatal coverage for a time period of 2 months each. Two months was considered to be an adequate period for patients to adapt to new overdentures and to give stable responses to questionnaires.<sup>3</sup> The present findings showed no significant deterioration of functional limitation or stability when the palatal overdenture coverage was reduced. These results are consistent with OHIP outcomes of similar studies on three to four maxillary implants supporting overdentures with and without palatal coverage.<sup>2,34</sup>

Regarding the effectiveness of palatal coverage in complete overdentures, a study found that eight out of 10 patients were more comfortable with reduced palatal coverage than with complete palatal coverage.<sup>21</sup> All the selected patients had a favorable residual ridge height. Considering these favorable conditions, the authors concluded that conventional overdentures with reduced palatal coverage could be as effective as overdentures with complete palatal coverage.<sup>21</sup>

Several clinical studies have evaluated the effect of palatal coverage at maxillary implant-supported overdentures.<sup>2,34–38</sup> In all studies, the overdentures were supported by a higher number of implants than in the present study.<sup>2,34–38</sup> Only two of these studies used an unsplinted attachment system like in the present study.<sup>34,35</sup> Three studies were of the same design as the present one and compared the effect of the palatal coverage in the same patient group (within-subject comparison).<sup>2,34,37</sup>

The most recent study evaluated three maxillary implants, which were splinted in 20 patients and unsplinted in another 20 patients.<sup>34</sup> Following 1 year of function with full palatal coverage, the palatal coverage was shortened and patient satisfaction was analyzed by means of OHIP questionnaires after another year of function. There was no significant difference with regard

to the prosthetic design (full or reduced palatal coverage, splinted or unsplinted implants). Most patients (85%) preferred dentures with reduced palatal coverage and did not report impaired retention.<sup>34</sup>

In a study on four maxillary-splinted implants, no significant differences with respect to general satisfaction, stability, retention, comfort, esthetics, and cleaning ability were observed for overdentures with and without palatal coverage.<sup>2</sup> According to the results of a clinical trial on speech with maxillary implant overdentures, no significant differences were found between overdentures supported by four implants with or without palatal coverage.<sup>37</sup>

On the basis of these results, including those from the current study, reduced palatal coverage of maxillary implant-supported overdentures seems to be satisfactory for patients and independent of the number of inserted implants.

## **Esthetics**

The finding that esthetics was significantly higher for overdentures without palatal coverage is difficult to explain as the overdentures did not change with concern to their outward appearance despite the removal of the palatal coverage. Reducing the palatal coverage reduced the palatal bulk and might have given the patients a more natural feeling, which in turn might have positively affected their perception of esthetics. A "more natural" feeling for overdentures without palatal coverage was in fact described in two patients in a previous within-subject comparison even though no significant differences for esthetics were detected between implant-supported overdentures with and without palatal coverage.<sup>2</sup>

#### Taste

Taste and ability to chew were listed to be among the most frequently reported criteria for success in implant dentistry at patient satisfaction level in a systematic review.<sup>39</sup> This was documented in the present study demonstrating a significantly improved taste sensation for overdentures without palatal coverage. These data are in accordance with several studies on conventional and implant-supported overdentures.<sup>14,20,21,34</sup> The appreciation of taste is a complex sequence of sensory and motor events including mastication, manipulation of the bolus, and deglutition.<sup>40</sup> The tactile sensation is thereby crucial for the taste when the tongue with its

taste buds is pressed against the palate, which is hindered in case of complete palatal coverage.

# **Functional Limitation**

Functional limitation represents the difficulty of chewing food among other factors influencing the function.<sup>41</sup> The patients in the present study were not much hampered when using overdentures with palatal coverage (mean OHIP score  $19.0 \pm 16.2$  mm) and without palatal coverage (mean OHIP score  $16.5 \pm 19.6$  mm). A study on maxillary overdentures supported by three implants reported slightly better scores for functional limitation both for dentures with (mean OHIP score  $13.4 \pm 2.6$ ) and without palatal coverage (mean OHIP score  $13.9 \pm 3.1$ ).<sup>34</sup> Likewise in the present study, functional limitation did not differ significantly for dentures with and without palatal coverage.<sup>34</sup>

#### Stability and Retention

In a recent review on implant overdentures, it was stated that the stability of the overdenture is enhanced when the implants are placed in the anterior maxilla.<sup>32</sup> Eliminating the palatal coverage of complete overdentures did not affect negatively the stability.<sup>21</sup> Thereby, occlusion is decisive and was thought to even enhance stability of a palateless maxillary overdenture when being well balanced and noninterfering.<sup>42</sup> The present results corroborate these findings with stability not compromised by the reduction of the palatal coverage. The anterior placement of the implants as well as the balanced occlusion might have added stability.

Aside from this finding, it was suggested to make a complete palatal coverage for maxillary overdentures supported by two implants in order to achieve adequate stability and retention.<sup>43</sup> In complete maxillary overdentures, reduction of the palatal coverage was shown to weaken the retentive potential.<sup>20,21,44</sup>

Different important factors are involved in overdenture retention, such as muscular retentive forces, forces associated with the attachment system, saliva amount and viscosity, overdenture supporting area, direction of insertion, and implant angulation.<sup>44,45</sup> In addition, neuromuscular reflexes develop and are conditioned by the overdenture outline, which enable the patient to tolerate newly designed overdentures after some time.<sup>44</sup> In the present study, all patients experienced problems with their conventional overdentures prior to inclusion to the study. It is plausible that the insertion of two implants improved overdenture retention independent of the extent of palatal coverage.

The evaluation of patient satisfaction is a decisive instrument to measure the effectiveness and success of a treatment.46,47 However, less than 2% of studies on implant overdentures cover patient-reported outcomes.<sup>41</sup> According to the outcomes of the ITI consensus conference in 2008, there is a need for clinical trials to scientifically and clinically validate the use of freestanding implants supporting overdentures with or without palatal coverage.9 The present study may offer a satisfactory, reasonably priced individual, patient-oriented treatment option.<sup>1,6</sup> One limitation is the rather small number of patients, even though it is higher than in other studies on two maxillary implants.48-50 The use of a within-subject study design offered several advantages. In this way, each subject served as its own control, which reduced error in variation associated with individual differences. The reduced variability in turn increased the power of the study.

## CONCLUSIONS

On the basis of these short-term results, patient satisfaction was favorable and similar for both implantsupported maxillary overdentures with and without palatal coverage. The majority of the patients preferred reduced palatal coverage.

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