

# Patient Satisfaction and Dissatisfaction with Mandibular Two-Implant Overdentures Using Different Attachment Systems: 5-Year Outcomes

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## ABSTRACT

*Background:* Different attachment systems for mandibular two-implant overdentures could influence levels of patient satisfaction. Positive consensus of the majority of patients being satisfied does not preclude the possibility of dissatisfaction for some.

*Purpose:* To evaluate patient satisfaction before and after 5 years of wearing mandibular two-implant overdentures using different attachment systems.

*Materials and Methods:* A total of 106 edentulous participants enrolled in a clinical trial completed a preliminary self-report inventory of their original complete denture complaints. New complete maxillary dentures and mandibular two-implant overdentures were provided to each participant using one of six different attachment systems. Patient satisfaction was determined at pretreatment; at baseline with mandibular two-implant overdenture insertion; and then annually for 5 years, using visual analogue and Likert-type scales.

*Results:* Patient satisfaction with mandibular two-implant overdentures at baseline was significantly improved in all domains compared to pretreatment (old dentures) and sustained up to the 5-year recall. The level of satisfaction with Straumann gold alloy matrices at 5 years was significantly lower than that with other attachment systems. Highly significant differences were found with some social and psychological aspects by the fifth year compared to baseline. Diagnostic and prognostic indicators from a pretreatment inventory identified 12 participants (13.5%) who were dissatisfied. These indicators revealed a maladaptive predisposition to mandibular two-implant overdentures.

*Conclusions:* A mandibular two-implant overdenture (opposing a conventional complete maxillary denture) will improve patient satisfaction, regardless of the attachment system. Careful evaluation of pretreatment complaints with conventional dentures can possibly identify patient dissatisfaction with mandibular two-implant overdentures.

**KEY WORDS:** attachment systems, mandibular implant overdentures, patient satisfaction

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## INTRODUCTION

Rehabilitation of edentulous patients with mandibular two-implant overdentures (opposing complete maxil-

lary dentures) is an established treatment paradigm with predictable outcomes.<sup>1,2</sup> Several attachment systems have been described for use with mandibular two-implant overdentures. Splinted implants make use of bar attachments made from precious or non-precious

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alloys.<sup>3</sup> Unsplinted implants, on the other hand, are often coupled to ball, stud, or magnetic attachments.<sup>4-7</sup>

Patient-based outcomes are primary measures of treatment success with complete dentures.<sup>8-11</sup> These outcomes are influenced by pain, discomfort, appearance, and chewing ability.<sup>12</sup> Edentulous patients who adapt to wearing conventional complete dentures still report difficulty in eating hard or tough foods. They often modify or become selective in their dietary intake<sup>13,14</sup>, with subsequent reduction in essential nutritional values.<sup>15</sup> This negatively impacts on levels of satisfaction and quality of life of patients wearing complete dentures.<sup>16-18</sup>

Historically, assessment of dissatisfied complete denture wearers, would include assessment of their psychological well-being and level of expectations.<sup>10-12,19-28</sup> Subsequently, the adaptive potentials of these patients to wearing complete dentures can be identified.<sup>29,30</sup> Moreover, complaints related to previous experiences with complete dentures have been proposed to be prognostic indicators for treatment outcomes with implant-supported prostheses.<sup>31</sup>

There is a consensus that with mandibular implant overdentures (opposing successful complete maxillary dentures), a significant improvement in stability and retention, oral function, psychological well-being, and social functioning can be achieved.<sup>6,16-18,32-41</sup> Patient satisfaction, as an outcome measure, with mandibular two-implant overdenture treatment has been extensively reported worldwide using various methods of assessment.<sup>1,2,7,16,18,33,42-56</sup> Findings suggest that, depending upon the attachment system used, the level of patient satisfaction is influenced by the amount of retention and stability of the implant overdenture.<sup>33</sup>

Crossover randomized, controlled clinical trials evaluating the influence of attachment system selection on patient satisfaction with mandibular two-implant overdentures are rare.<sup>33</sup> They usually have been comparing both splinted attachments (bar) and unsplinted attachment systems (balls, magnets). Randomized clinical trials using exclusively ball attachment systems of varied designs are still lacking.

The aims of this research were to evaluate patient satisfaction before and after 5 years of treatment with mandibular two-implant overdentures using different ball attachment systems; to identify edentulous patients who were dissatisfied with mandibular two-implant overdentures; and to determine the prognostic relevance

of pretreatment complete denture complaints to treatment outcomes with mandibular two-implant overdentures.

## MATERIALS AND METHODS

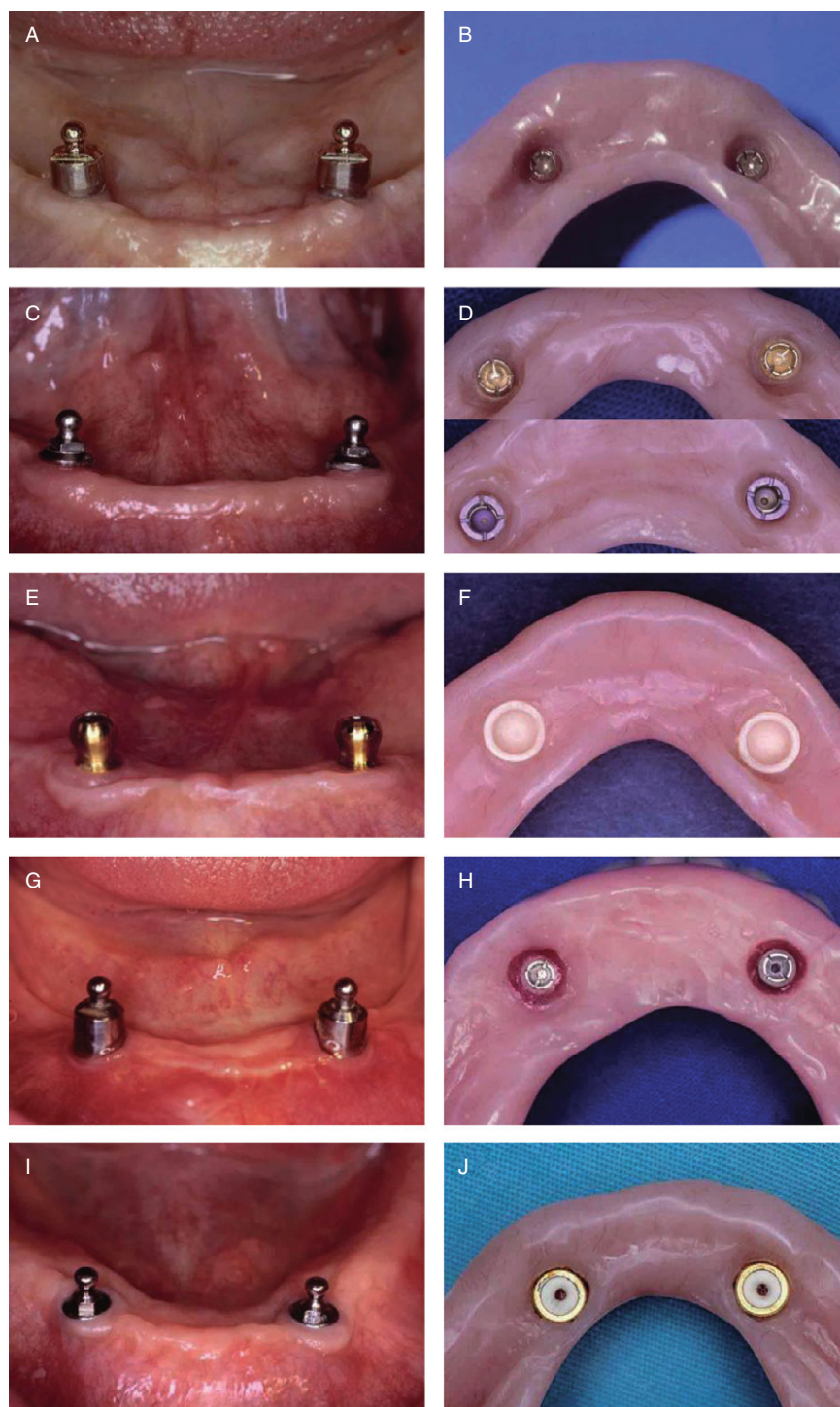
### Patient Sample

A total of 106 edentulous participants (mean age 65.3, SD 7.4 years) with a history of functional difficulties with their complete dentures were selected using standard inclusion and exclusion criteria for a randomized control trial.<sup>57</sup> Ethical approval was obtained from the Lower South Ethics Committee, New Zealand. Participants had been edentulous for a mean period of 34.7 years (SD 13.4) and most had worn more than three sets of conventional complete dentures. The mean age of the previous complete dentures was 10.2 years, and most had been adjusted and/or relined during the last years of use.

Using sealed envelopes and a table of random numbers, participants were randomly allocated to treatment with mandibular two-implant overdentures using one of four different implant systems (Brånemark, Nobel Biocare, Göteborg, Sweden; Steri-Oss, Nobel Biocare, Göteborg, Sweden; Straumann, Waldenburg, Switzerland; Southern Implants, Irene, South Africa). All the new complete maxillary dentures and mandibular two-implant overdentures were fabricated using standard technique with the same method of abutment selection, impression procedures, jaw relation records, occlusal scheme (bilateral balanced occlusion), denture teeth (Orthotype, Ivoclar, Lichtenstein), delivery procedures, and post-insertion procedures. Each participant was provided with one of six different overdenture attachment systems (Figure 1).

### Pretreatment Questionnaires

All participants completed a self-report inventory on their existing complete dentures evaluating their denture history.<sup>12,29</sup> The inventory focused on general and main denture complaints, together with other denture-related variables. These included participant's experience and evaluation of pain, appearance, mastication, speech, retention, denture breakage, food collecting underneath dentures, burning sensations, an awareness of denture wear (related to their perception that there was a reduction of vertical dimension of occlusion), tongue biting, cheek biting, and clicking. Visual



**Figure 1** Different implant overdenture attachment systems: (A) Brånemark 2.25 mm ball matrix; (B) Brånemark gold matrix; (C) Straumann 2.25 mm retentive anchor; (D) Straumann gold matrix (top), Straumann titanium matrix with stainless steel spring (bottom); (E) Southern 3.95 mm ball matrix; (F) Southern plastic matrix; (G) Southern 2.25 mm ball matrix; (H) Southern gold alloy matrix; (I) Steri-Oss ball matrix; (J) Steri-Oss rubber matrix. Reprinted with permission from Quintessence Publishing.

analogue scale (VAS) questionnaires were also completed as a pretreatment measurement tool to assess patients' satisfaction with their existing complete dentures.<sup>38,55,56</sup> With this, each participant was asked to place

a cross on a 10-cm straight line to indicate his rate of satisfaction on eight denture-related domains (stability, pain, comfort, appearance, function, speech, cleaning difficulty, and overall satisfaction).

## Post-treatment Questionnaires

Qualitative data from participants with their new complete maxillary dentures and mandibular two-implant overdentures were measured at baseline (4 weeks after delivery) and annually thereafter for 5 years using the same VAS. Participants were asked, again, to rate the same eight domains of satisfaction but with the new dentures. In addition, all participants were also asked to complete another Likert-type scale with nine response categories (1 = very bad through 9 = very good).<sup>44</sup> In that questionnaire, the participants rated their overall satisfaction with the mandibular two-implant overdentures as well as the specific aspects of stability, function, speech, appearance, and food accumulation underneath the mandibular two-implant overdenture. There were also three final questions (adapted from Blomberg 1992)<sup>58</sup> related to social and psychological aspects of wearing the mandibular two-implant overdentures with six response categories to select from (1 = much worse through 6 = better).

Qualitative data were gathered from interviews with participants to determine specific aspects relevant to their satisfaction or dissatisfaction. The format was not a structured one, but rather an informal discussion on a clinician – patient basis using open-ended questions.

## Statistical Analysis

Data were analyzed using SPSS (SPSS Inc., Chicago, IL, USA) statistical software. Group mean scores for each of the VAS and Likert-type scale items were calculated. Apparent differences, including that of attachment systems, were then tested for statistical significance using independent samples *t*-tests or analysis of variance (for intergroup differences) or paired *t*-tests (for intragroup changes over time). The level of significance was set at  $p < 0.05$ .

## RESULTS

All 106 edentulous participants completed the pretreatment questionnaires. Progressive attrition of participants occurred with deaths, dropouts, and emigration which meant that 100 participants were assessed at the 1-year recall, 96 participants were assessed at the 3-year recall, and 95 participants were assessed at the 5-year recall.

## Quantitative Data

*Self-Report Inventory.* With conventional complete maxillary dentures, the most common general complaints (in descending order) were food collecting underneath the denture, looseness, problems with eating, and pain. With the conventional complete mandibular dentures, food collecting underneath the denture was also the most common complaint followed by looseness, denture wear, and problems with eating. When required to identify their main complaint, looseness and food collecting underneath the complete mandibular denture was considered equally by one-third of participants. With the conventional complete maxillary denture, food collecting underneath the denture was identified as the main complaint by one out of five participants (Table 1).

*Participant Satisfaction Scores over 5 Years.* The baseline VAS scores revealed significant improvement with both the new complete maxillary dentures and mandibular two-implant overdentures compared to pretreatment scores across all of the variables (Table 2). This improvement was maintained throughout the 5 years with no observed significant difference in all variables, except for pain with the mandibular two-implant overdenture. This was just significantly different with mandibular two-implant overdenture at the 5-year follow-up ( $p = 0.04$ ).

The Likert-type scale data are presented in Table 3. No statistically significant changes were observed in the overall general satisfaction, stability, function, speech, appearance, and food accumulation underneath the mandibular two-implant overdenture from baseline and all through the 5 years. For social and psychological variables, however, some highly significant improvements were observed. For example, social contact with other people and the psychological impact while wearing mandibular two-implant overdentures has significantly improved compared to baseline.

Analysis of post-treatment VAS and Likert-type scale data identified 12 participants (13.5%) to be dissatisfied with their mandibular two-implant overdentures.

*Influence of Attachment System.* At baseline with insertion of the mandibular two-implant overdenture, the VAS scores revealed significantly lower improvement in terms of function and stability for participants with Straumann gold matrices compared to other attachment

**TABLE 1 Prevalence of the Pretreatment Old Conventional Denture Complaints Using a Self-Report Inventory<sup>12</sup>**

	Maxillary Denture ( <i>General Complaints</i> )	Mandibular Denture ( <i>General Complaints</i> )	Maxillary Denture ( <i>Main Complaint</i> )	Mandibular Denture ( <i>Main Complaint</i> )
Pain or soreness	13.5%	68.5%	6.7%	31.5%
Appearance	21.3%	34.8%	4.5%	1.1%
Eating	25.8%	84.3%	3.4%	4.5%
Talking	19.1%	39.3%	3.4%	1.1%
Looseness	30.3%	88.8%	13.5%	31.5%
Breakage	13.5%	6.7%	5.6%	1.1%
Food collection underneath	48.3%	98.9%	31.5%	19.1%
Burning or drawing sensation	6.7%	22.5%	–	–
Denture wearing away	30.3%	39.3%	5.6%	–
Biting tongue	21.3%	31.5%	6.7%	2.2%
Biting cheek	24.7%	37.1%	2.2%	1.1%
Click or noise	22.5%	40.4%	3.4%	4.5%
Other problems	20.2%	33.7%	5.6%	2.2%

**TABLE 2 Mean (SD) Scores for Patient Satisfaction at Pretreatment, Baseline, and Year 5 with Visual Analogue Scales<sup>55</sup>**

Variables	Pretreatment (Old Dentures)	Baseline ( <i>With Mandibular Two-Implant Overdenture</i> )	At Year 5 ( <i>With Mandibular Two-Implant Overdenture</i> )	<i>p</i> Value for Comparison Between Time Points	
				Pretreatment to Baseline	Baseline to Year 5
Maxillary denture					
Pain	7.47 (1.91)	7.98 (1.52)	8.23 (1.34)	0.035*	0.24
Comfort	7.08 (1.94)	7.73 (1.70)	8.04 (1.30)	0.007*	0.12
Appearance	6.23 (2.78)	8.03 (1.26)	7.81 (1.49)	0.001*	0.25
Function	6.51 (2.22)	7.97 (1.18)	7.77 (1.40)	0.001*	0.22
Stability	6.72 (2.28)	7.82 (1.61)	7.42 (1.87)	0.001*	0.92
Cleaning difficulty	7.15 (1.90)	7.97 (1.75)	8.09 (0.91)	0.001*	0.56
Overall satisfaction	6.79 (2.22)	7.87 (1.62)	7.95 (1.42)	0.001*	0.65
Mandibular denture					
Pain	4.04 (3.15)	7.80 (1.52)	8.21 (1.32)	0.001*	0.04*
Comfort	3.33 (2.77)	8.64 (8.42)	7.72 (1.80)	0.001*	0.30
Appearance	5.11 (2.97)	8.04 (1.45)	7.72 (1.79)	0.001*	0.09
Function	3.24 (2.61)	7.49 (1.77)	7.52 (1.83)	0.001*	0.88
Stability	2.93 (2.90)	7.73 (1.71)	7.66 (1.31)	0.001*	0.92
Cleaning difficulty	6.60 (2.43)	7.88 (1.51)	8.02 (1.15)	0.001*	0.44
Overall satisfaction	3.04 (2.65)	7.89 (1.56)	7.79 (1.65)	0.001*	0.63
Speech	6.77 (2.06)	8.01 (1.17)	7.98 (1.24)	0.010*	0.90

A higher value (in cm) indicates higher level of satisfaction on the 10-cm VAS scale.

\*Statistically significant differences.

**TABLE 3 Mean Scores for Mandibular Two-Implant Overdenture Ratings at Baseline and Year 5 Using Likert-Type Scales<sup>44,58</sup>**

	Baseline Mean (SD)	Year 5 Mean (SD)	p Value for Baseline–Year 5 Comparison
Mandibular overdenture ratings (9-point scale)(higher/better)			
How do you find your overdenture on the whole?	7.89 (1.48)	8.16 (1.25)	0.15
How well does your overdenture stay in place?	7.93 (1.66)	7.82 (1.30)	0.53
How does your overdenture function when chewing?	7.74 (1.73)	7.93 (1.42)	0.30
How does your overdenture function when talking?	8.18 (1.36)	8.28 (0.99)	0.48
How do you find the appearance of your overdenture?	8.31 (1.40)	8.33 (1.24)	0.94
How do you find the food accumulation underneath the overdenture?	6.49 (1.99)	6.31 (1.81)	0.41
Social aspects (5-point scale)(higher/better)			
Has having an implant-supported overdenture affected your working ability compared with your previous denture?	4.67 (1.42)	4.94 (1.40)	0.10
Has having an implant-supported overdenture affected your contact with other people?	4.10 (1.43)	4.71 (1.44)	0.004*
Psychological aspects (5-point scale)(higher/better)			
Do you think your confidence and self esteem are affected by having an implant overdenture?	4.51 (1.38)	4.79 (1.32)	0.85
Has having an implant-supported overdenture affected you psychologically?	2.67 (0.83)	2.70 (0.88)	0.001*

\*Statistically significant differences.

systems (Table 4). After 5 years, however, no significant differences were observed with the mandibular two-implant overdenture across all attachment systems. With the opposing new complete maxillary dentures, the attachment system was found to have no significant influence on patient satisfaction.

### Qualitative Data

From the 12 participants (13.5%) identified to be dissatisfied with their mandibular two-implant overdentures using Likert scales, further analysis was performed correlating each participant back to their self-report inventory on their original existing complete dentures. The data identified that these individual participants had an excessively high number of complaints about their mandibular two-implant overdentures, as well as reporting pain, burning sensations, and food accumulation under their old existing complete maxillary denture.

Some comments from patients dissatisfied with the mandibular two-implant overdenture treatment ascertained specific aspects related to the degree of or reason for dissatisfaction:

- “these implants have been of no use to me – I would rather have them taken out”
- “the fit of the clips onto the implants was initially useless, and is still no better”
- “the studs keep coming loose or wearing out”
- “the rubber rings were always OK for two weeks and then slowly perished after that”
- “the shape of my lower denture is still all wrong – it is too long and cramping my tongue”
- “I keep getting pain and ulcers – are you sure that I do not need more implants further back?”
- “my joints still hurt”
- “I think more of my implants should be showing for the denture to clip on better, but – I am not prepared to have more surgery again to cut the gum away”
- “my expectations were higher. I thought the implant denture would be more solid in my mouth, but after all I have always hated having false teeth”
- “I find food collecting underneath the lower denture most frustrating, especially when the clips start to lose their fit – and that is quite often”

**TABLE 4 Mandibular Two-Implant Overdentures; Levels of Patient Satisfaction with Different Attachment Systems Using Visual Analogue Scales<sup>55</sup> (cm on a 10cm scale)**

	Steri-Oss Rubber Ring	Southern Plastic	Southern Gold Alloy	Straumann Gold	Straumann Titanium	BM Gold	p Value
Baseline							
Pain	7.81 (1.49)	7.98 (0.99)	7.88 (2.22)	7.39 (2.16)	8.11 (1.18)	7.66 (1.01)	0.86
Comfort	7.91 (1.22)	7.94 (0.82)	8.41 (0.99)	6.96 (2.59)	8.15 (1.28)	7.61 (0.97)	0.14
Appearance	8.16 (1.49)	8.27 (0.54)	7.90 (2.25)	7.71 (2.09)	8.23 (0.87)	7.74 (1.27)	0.82
Function	8.23 (0.75)	7.84 (0.95)	7.42 (2.72)	6.28 (2.57)	6.70 (1.73)	7.02 (1.15)	0.02*
Stability	8.39 (0.71)	8.00 (1.14)	8.08 (1.37)	6.26 (2.81)	7.72 (1.49)	7.72 (1.48)	0.001*
Cleaning difficulty	8.11 (0.91)	7.47 (1.52)	8.12 (1.84)	7.78 (2.09)	8.23 (1.27)	7.91 (1.35)	0.71
Overall satisfaction	8.22 (1.42)	8.05 (1.26)	8.29 (0.97)	6.99 (2.33)	7.82 (1.65)	7.97 (0.96)	0.21
Speech	8.03 (1.46)	7.92 (1.20)	8.21 (1.15)	7.91 (1.04)	8.43 (0.76)	7.69 (1.14)	0.77
5-year recall							
Pain	8.22 (1.25)	8.23 (0.72)	8.44 (0.86)	8.47 (0.77)	7.64 (3.13)	8.09 (0.61)	0.72
Comfort	8.07 (1.61)	7.69 (1.38)	8.08 (1.28)	7.64 (1.71)	7.22 (3.00)	7.35 (2.22)	0.80
Appearance	8.00 (2.09)	8.15 (0.72)	8.01 (1.12)	6.72 (2.79)	7.57 (1.33)	7.63 (1.58)	0.21
Function	7.72 (1.91)	7.93 (0.90)	7.82 (1.74)	6.68 (2.72)	7.35 (1.94)	7.42 (1.45)	0.42
Stability	8.22 (1.26)	6.80 (2.06)	7.08 (2.45)	7.41 (1.93)	5.76 (2.42)	7.40 (1.96)	0.45
Cleaning difficulty	7.87 (1.83)	8.03 (0.79)	8.11 (1.05)	8.09 (0.97)	7.88 (1.12)	8.19 (0.47)	0.97
Overall satisfaction	7.88 (1.77)	8.03 (0.66)	8.38 (0.72)	6.89 (2.77)	7.64 (1.46)	8.06 (1.18)	0.22
Speech	8.33 (1.12)	7.93 (0.80)	8.04 (1.22)	7.90 (1.64)	8.15 (0.61)	7.35 (1.93)	0.49

\*TTI gold matrix showed lower improvement (statistically significant) in mandibular overdenture function and stability compared to other matrices.

- “The overdenture does not stay put – I think I need more implants”

## DISCUSSION

This research evaluated patient outcomes for edentulism using mandibular two-implant overdentures, opposing complete maxillary dentures over 5 years. The influence of the specific type of attachment system used with mandibular two-implant overdenture on the level of patient satisfaction was determined. Patients dissatisfied with their mandibular two-implant overdenture were also identified, and aspects relevant to their dissatisfaction were analyzed. Pertinent information on pretreatment denture complaints (with old complete dentures) appeared to impact on treatment outcomes for some participants with mandibular two-implant overdentures.

As part of the randomized trial, all participants originally had a new set of complete maxillary and mandibular dentures (diagnostic dentures) made, prior to implant treatment. The participants then went from wearing their new diagnostic complete maxillary and mandibular dentures, directly to the new complete maxillary denture, opposing the mandibular two-implant overdenture. We acknowledge, in terms of limitations of our research, that this construction of a new set of conventional complete maxillary and mandibular dentures could have influenced the ratings in the respective domains of the VAS and Likert-type scales. This is as opposed to the private practice scenario of directly converting old complete dentures to new complete maxillary denture, opposing the mandibular two-implant overdenture. The number of participants reduced only slightly from the original 106 to 95 participants by the fifth year recall. Although it is acknowledged that if we had been able to maintain the original sample size of 106 participants, the statistical power would have been better; however, in terms of the reality of ongoing clinical trials with aging participants, this was positive. Finally, we acknowledge that by using VAS and Likert scales, we ran the risk of falling short in assessing the effect of dental care on the person as a whole as compared to oral health impact profile scales.<sup>59,60</sup>

We have reported in this research on the levels of patient satisfaction and standardizing the parameter of the attachment system which was for unsplinted prosthodontic designs. No randomized controlled clinical trials on mandibular two-implant overdentures have

had as many as six different unsplinted attachment systems within four different implant systems.<sup>2,33</sup> Regardless of our incidental finding for some isolated variables related to the Straumann gold matrix participants, we have found that levels of patient satisfaction do not vary between the ball attachment types. The participants could only compare their mandibular two-implant overdenture using one attachment system; to their previous complete mandibular dentures, it is acknowledged that the participants were not able to experience different attachment systems. Therefore, the type of ball attachment system to be selected may be clinically irrelevant in terms of individual patients in clinical practice. It may be different if patients have had the opportunity to experience different matrices when participating in a crossover trial where there is stronger evidence.<sup>33</sup>

At the time of commencement of this research, Straumann was still marketing the traditional Dalla Bona gold matrix which was simply activated or deactivated by opening or closing the four lamellae. We used it for our participants as opposed to the current Dalla Bona plus rotational matrices with the option of adjustable retentive force and ease of replacement of their gold inserts. This Straumann traditional Dalla Bona gold matrix was maintained during the 5 years to avoid introducing confounding variables that might influence patient outcomes.

The Straumann group was less satisfied in terms of function and stability at baseline. While no factor can be singled out for this occurrence, two variables may be of major influence. First, the retentive quality of the attachment system has a direct impact on patient satisfaction and choice of the retentive element as has already been described in the literature.<sup>33</sup> The retention of the overdenture is dependent upon the material composition and the design of the attachment used, and hence, differences between attachment systems can result in different retentive qualities. Second, there are individual variations among patients in the perception of adequate retention, stability, and function of an overdenture. Patients' demands and expectations of treatment also differ and could impact negatively on the treatment outcome. The fact that at the 5-year recall all attachments achieved comparable level of satisfaction could have been the result of better adaptation of the patients to their specific interventions or to the habituation effect of the overdenture with time.



Direct comparison of our findings to those of other investigators is restricted by differences in study designs and methods of reporting. Our overall findings, however, were similar to those reported by others.<sup>1,7,17,33,38,42,43,45</sup> Two research centers, the Leuven group (Belgium) and the University of British Columbia (Canada), have used similar methodology to that used in our study which does facilitate aspects of comparison. From the Leuven group (Belgium), a 10-year report on the outcome of mandibular overdentures on two splinted or unsplinted implants,<sup>2</sup> the Likert score range at 5 years was 7.8 to 8.6, which is similar to that reported in our study. The level of patient satisfaction was then sustained throughout the subsequent 5 years at no significant level; however, splinted and unsplinted designs were compared, albeit with one ball attachment design only.

From the University of British Columbia group (Canada), patient satisfaction was evaluated for mandibular two-implant overdentures using the VAS questionnaires.<sup>55</sup> Functional improvement and improved level of patient satisfaction was reported. The level of satisfaction was irrespective of the type of prosthodontic design used for the overdentures (splinted or unsplinted). It is relevant, however, that in contrast to our study, no pretreatment evaluation of denture complaints were obtained. In a subsequent prospective 1- and 2-year reports from the same center,<sup>38,56</sup> the authors also reported significant improvement with mandibular two-implant overdentures across all eight domains of the VAS scale compared to pretreatment scores. Consistent with our findings at 5 years, MacEntee and colleagues<sup>38</sup> found no significant differences in the VAS scores at the 2-year follow-up. The Canadian researchers<sup>38</sup> also found that "overall satisfaction" did not differ between their two attachment groups, and they were also using both unsplinted and splinted prosthodontic designs of one implant system.

A correlation was found between some complete maxillary denture complaints and later dissatisfaction with mandibular two-implant overdenture treatment. A small, but relevant, minority of mandibular implant overdenture patients will still be maladaptive and reject, or have problems, or score low levels of satisfaction with prescribed mandibular two-implant overdentures, regardless of attachment system used. The etiology is multifactorial and could be related to something as simple as residual mandibular ridge height.<sup>61</sup>

Where patients reported either pain under old existing complete maxillary denture, or food accumulation with burning sensations, there were potentially prognostic indicators that indicated that the mandibular two-implant overdenture did not meet their expectations. This is relevant to prosthodontists and clinicians who alternatively recommend mandibular fixed implant bridges or even no implant intervention at all.

Our findings have also identified that there could be an advantage to using the pretreatment inventory<sup>12</sup> to assess patients' subjective experiences with conventional dentures before embarking on implant overdenture treatment.<sup>31</sup> Our findings are in agreement with Kotkin and colleagues<sup>31</sup> who concluded that prognostic indicators developed in an initial self-report inventory can assist clinicians to recognize maladaptive patients who may not be satisfied with implant treatment. Evaluation of patients' pretreatment complaints with their conventional maxillary and mandibular dentures before implant therapy is hence recommended.

## CONCLUSIONS

The provision of mandibular two-implant overdentures will, in the majority of patients, significantly enhance levels of patient satisfaction for 5 years, as compared to complete mandibular dentures. This level of patient satisfaction is not influenced by the type of the attachment system used for unsplinted prosthodontic designs of mandibular two-implant overdentures.

Diagnostic and prognostic indicators from a pretreatment inventory can assist to identify a minority of patients with a maladaptive predisposition to mandibular two-implant overdenture treatment.

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## REFERENCES

- Meijer HJ, Raghoobar GM, Van't Hof MA. Comparison of implant-retained mandibular overdentures and conventional complete dentures: a 10-year prospective study of clinical aspects and patient satisfaction. *Int J Oral Maxillofac Implants* 2003; 18:879–885.
- Naert I, Alsaadi G, Quirynen M. Prosthetic aspects and patient satisfaction with two-implant-retained mandibular overdentures: a 10-year randomized clinical study. *Int J Prosthodont* 2004; 17:401–410.
- Preiskel HW. Bar attachments. In: Preiskel HW, ed. *Overdentures made easy: a guide to implant and root supported prostheses*. London: Quintessence Publishing Co, Inc., 1996:105–137.
- Meijer HJ, Raghoobar GM, Van't Hof MA, Geertman ME, Van Oort RP. Implant-retained mandibular overdentures compared with complete dentures; a 5-years' follow-up study of clinical aspects and patient satisfaction. *Clin Oral Implants Res* 1999; 10:238–244.
- Pera P, Bassi F, Schierano G, Appendino P, Preti G. Implant anchored complete mandibular denture: evaluation of masticatory efficiency, oral function and degree of satisfaction. *J Oral Rehabil* 1998; 25:462–467.
- van Kampen FM, van der Bilt A, Cune MS, Fontijn-Tekamp FA, Bosman F. Masticatory function with implant-supported overdentures. *J Dent Res* 2004; 83:708–711.
- Wismeijer D, Vermeeren JI, van Waas MA. Patient satisfaction with overdentures supported by one-stage TPS implants. *Int J Oral Maxillofac Implants* 1992; 7:51–55.
- Appelby RC, Ludwig TF. Patient evaluation for complete denture therapy. *J Prosthet Dent* 1970; 24:11–17.
- Bell DH. Problems in complete denture treatment. *J Prosthet Dent* 1968; 19:550–560.
- Berg E, Johnsen TB, Ingebretsen R. Social variables and patient acceptance of complete dentures. A study of patients attending a dental school. *Acta Odontol Scand* 1985; 43:199–203.
- Hirsch B, Levin B, Tiber N. Effect of patient involvement and aesthetic preference on denture acceptance. *J Prosthet Dent* 1972; 28:127–132.
- Kotkin H. Diagnostic significance of denture complaints. *J Prosthet Dent* 1985; 53:73–77.
- Allen F, McMillan A. Food selection and perceptions of chewing ability following provision of implant and conventional prostheses in complete denture wearers. *Clin Oral Implants Res* 2002; 13:320–326.
- Sheiham A, Steele JG, Marcenes W, Finch S, Walls AW. The impact of oral health on stated ability to eat certain foods; findings from the National Diet and Nutrition Survey of Older People in Great Britain. *Gerodontology* 1999; 16:11–20.
- Morais JA, Thomason JM. Edentulous, digestion and nutrition. In: Feine JS, Carlsson GE, eds. *Implant overdentures: the standard of care for edentulous patients*. Chicago, IL: Quintessence Publishing Co., Inc, 2003:15–21.
- Awad MA, Locker D, Korner-Bitensky N, Feine JS. Measuring the effect of intra-oral implant rehabilitation on health-related quality of life in a randomized controlled clinical trial. *J Dent Res* 2000; 79:1659–1663.
- Thomason JM, Lund JP, Chehade A, Feine JS. Patient satisfaction with mandibular implant overdentures and conventional dentures 6 months after delivery. *Int J Prosthodont* 2003; 16:467–473.
- Awad MA, Lund JP, Shapiro SH, et al. Oral health status and treatment satisfaction with mandibular implant overdentures and conventional dentures: a randomized clinical trial in a senior population. *Int J Prosthodont* 2003; 16:390–396.
- Berg E, Johnsen TB, Ingebretsen R. Psychological variables and patient acceptance of complete dentures. *Acta Odontol Scand* 1986; 44:17–22.
- Bergman B, Carlsson GE. Clinical long-term study of complete denture wearers. *J Prosthet Dent* 1985; 53:56–61.
- Guckes AD, Smith DE, Swoope CC. Counselling and related factors influencing satisfaction with dentures. *J Prosthet Dent* 1978; 39:259–267.
- Narin RI, Brunello DL. The relationship of denture complaints and the level of neuroticism. *Dent Pract* 1971; 21:56–58.
- Smith H. Measurement of personality traits and their relation to patient satisfaction with complete dentures. *J Prosthet Dent* 1976; 35:492–503.
- van Waas MA. The influence of psychologic factors on patient satisfaction with complete dentures. *J Prosthet Dent* 1990; 63:545–548.
- van Waas MA. Determinants of dissatisfaction with dentures: a multiple regression analysis. *J Prosthet Dent* 1990; 64:569–572.
- van Waas MA. The influence of clinical variables on patients' satisfaction with complete dentures. *J Prosthet Dent* 1990; 63:307–310.
- Vervoorn JM, Duinkerke AS, Luteijn F, van de Poel AC. Assessment of denture satisfaction. *Community Dent Oral Epidemiol* 1988; 16:364–367.
- Vervoorn JM, Duinkerke AS, Luteijn F, van de Poel AC. Relative importance of psychologic factors in denture satisfaction. *Community Dent Oral Epidemiol* 1991; 19:45–47.
- Kotkin H, Slabbert JC, Becker PJ. The prognostic value of denture complaints. *Int J Prosthodont* 1993; 6:341–345.
- Zarb GA. The edentulous predicament. In: Zarb GA, Bolender CL, eds. *Prosthodontic treatment for edentulous patients: complete dentures and implant-supported prostheses*. St. Louis: Mosby, 2004:3–5.

31. Kotkin H, Slabbert JC, Becker PJ, Carr L. Perceptions of complete dentures by prospective implant patients. *Int J Prosthodont* 1998; 11:240–245.
32. Allen PF, McMillan AS, Walshaw D. A patient-based assessment of implant-stabilized and conventional complete dentures. *J Prosthet Dent* 2001; 85:141–147.
33. Cune M, van Kampen F, van der Bilt A, Bosman F. Patient satisfaction and preference with magnet, bar-clip, and ball-socket retained mandibular implant overdentures: a cross-over clinical trial. *Int J Prosthodont* 2005; 18:99–105.
34. Geertman ME, van Waas MA, van't Hof MA, Kalk W. Denture satisfaction in a comparative study of implant-retained mandibular overdentures: a randomized clinical trial. *Int J Oral Maxillofac Implants* 1996; 11:194–200.
35. Heydecke G, Klemetti E, Awad MA, Lund JP, Feine J. Relationship between prosthodontic evaluation and patient ratings of mandibular conventional and implant prostheses. *Int J Prosthodont* 2003; 16:307–312.
36. Kent G, Johns R. Controlled longitudinal study on the psychological effects of osseointegrated dental implants. *Int J Oral Maxillofac Implants* 1991; 6:470–474.
37. Kent G, Johns R. Effects of osseointegrated implants on psychological and social well-being: a comparison with replacement removable prostheses. *Int J Oral Maxillofac Implants* 1994; 9:103–106.
38. MacEntee MI, Walton JN, Glick N. A clinical trial of patient satisfaction and prosthodontic needs with ball and bar attachments for implant-retained complete overdentures: three-year results. *J Prosthet Dent* 2005; 93:28–37.
39. Melas F, Marcenes W, Wright PS. Oral health impact on daily performance in patients with implant-stabilized overdentures and patients with conventional complete dentures. *Int J Oral Maxillofac Implants* 2001; 16:700–712.
40. Stellingsma K, Bouma J, Stegenga B, Meijer HJ, Raghoebar GM. Satisfaction and psychosocial aspects of patients with an extremely resorbed mandible treated with implant-retained overdentures. A prospective, comparative study. *Clin Oral Implants Res* 2003; 14:166–172.
41. Strub JR, Mylonas T, Beyer T, Weingart D. Functional state of edentulous patients with implant-supported fixed prostheses and implant-retained overdentures: preliminary results. *Int J Oral Maxillofac Implants* 1994; 9:513–521.
42. Boerrigter EM, Geertman ME, Van Oort RP, et al. Patient satisfaction with implant-retained mandibular overdentures. A comparison with new complete dentures not retained by implants – a multicentre randomized clinical trial. *Br J Oral Maxillofac Surg* 1995; 33:282–288.
43. Cune MS, de Putter C, Hoogstraten J. Treatment outcome with implant-retained overdentures: part II – Patient satisfaction and predictability of subjective treatment outcome. *J Prosthet Dent* 1994; 72:152–158.
44. Naert IE. An influence of prosthetic design and implant type on tissue reactions around oral implants. PhD thesis, Leuven University Press, 1991.
45. Raghoebar GM, Meijer HJ, van't Hof M, Stegenga B, Vissink A. A randomized prospective clinical trial on the effectiveness of three treatment modalities for patients with lower denture problems. A 10-year follow-up study on patient satisfaction. *Int J Oral Maxillofac Surg* 2003; 32:498–503.
46. Timmerman R, Stoker GT, Wismeijer D, Oosterveld P, Vermeeren JI, van Waas MA. An eight-year follow-up to a randomized clinical trial of participant satisfaction with three types of mandibular implant-retained overdentures. *J Dent Res* 2004; 83:630–633.
47. Wismeijer D, Van Waas MA, Vermeeren JI, Mulder J, Kalk W. Patient satisfaction with implant-supported mandibular overdentures. A comparison of three treatment strategies with ITI-dental implants. *Int J Oral Maxillofac Surg* 1997; 26:263–267.
48. Bakke M, Holm B, Gotfredsen K. Masticatory function and patient satisfaction with implant-supported mandibular overdentures: a prospective 5-year study. *Int J Prosthodont* 2002; 15:575–581.
49. de Grandmont P, Feine JS, Tache R, et al. Within-subject comparisons of implant-supported mandibular prostheses: psychometric evaluation. *J Dent Res* 1994; 73:1096–1104.
50. Feine JS, de Grandmont P, Boudrias P, et al. Within-subject comparisons of implant-supported mandibular prostheses: choice of prosthesis. *J Dent Res* 1994; 73:1105–1111.
51. Feine JS, Dufresne E, Boudrias P, Lund JP. Outcome assessment of implant-supported prostheses. *J Prosthet Dent* 1998; 79:575–579.
52. Fueki K, Kimoto K, Ogawa T, Garrett NR. Effect of implant-supported or retained dentures on masticatory performance: a systematic review. *J Prosthet Dent* 2007; 98:470–477.
53. Heydecke G, Thomason JM, Lund JP, Feine JS. The impact of conventional and implant supported prostheses on social and sexual activities in edentulous adults. Results from a randomized trial 2 months after treatment. *J Dent* 2005; 33:649–657.
54. Tang L, Lund JP, Tache R, Clokie CM, Feine JS. A within-subject comparison of mandibular long-bar and hybrid implant-supported prostheses: psychometric evaluation and patient preference. *J Dent Res* 1997; 76:1675–1683.
55. Walton JN, MacEntee MI. Problems with prostheses on implants: a retrospective study. *J Prosthet Dent* 1994; 71:283–288.
56. Walton JN, MacEntee MI, Glick N. One-year prosthetic outcomes with implant overdentures: a randomized clinical trial. *Int J Oral Maxillofac Implants* 2002; 17:391–398.
57. Payne A, Tawse-Smith A, Thomson W, Duncan W. Loading strategies for mandibular implant overdentures. In: Feine JS, Carlsson GE, eds. *Implant overdentures: the standard of care for edentulous patients*. Chicago: Quintessence Publishing Co., Inc, 2003:111–128.

58. Blomberg S. Psychological aspects of treatment results and patient selection. In: Worthington P, Branemark P, eds. *Advanced osseointegration surgery: applications in the maxillofacial region*. Chicago, IL: Quintessence Publishing Co., Inc, 1992:347–352.
59. Strassburger C, Heydecke G, Kerschbaum T. Influence of prosthetic and implant therapy on satisfaction and quality of life: a systematic literature review. Part 1 – characteristics of the studies. *Int J Prosthodont* 2004; 17:83–93.
60. Strassburger C, Kerschbaum T, Heydecke G. Influence of implant and conventional prostheses on satisfaction and quality of life: a literature review. Part 2: qualitative analysis and evaluation of the studies. *Int J Prosthodont* 2006; 19:339–348.
61. Kimoto K, Garrett NR. Effect of mandibular ridge height on patients' perceptions with mandibular conventional and implant-assisted overdentures. *Int J Oral Maxillofac Implants* 2005; 20:762–768.