Patient Satisfaction with Maxillary 3-Implant Overdentures Using Different Attachment Systems Opposing Mandibular 2-Implant Overdentures

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ABSTRACT

Background: Patient-based outcomes with maxillary overdentures on a minimum number of implants, opposing mandibular 2-implant overdentures are not evident in the literature.

Purpose: To evaluate patient's satisfaction with maxillary 3-implant overdentures, opposing mandibular 2-implant overdentures, using two different attachment systems over the first 2 years of service.

Materials and Methods: Forty participants wearing mandibular 2-implant overdentures for 3 years were randomly allocated to one of two similar implant system groups to receive maxillary 3-implant overdentures. Twenty participants were allocated to splinted and unsplinted attachment system treatment groups for each system. Patient satisfaction with pre-treatment complete maxillary dentures, with maxillary 3-implant overdentures at baseline and annually for 2 years, was measured using visual analogue scale questionnaires and the oral health impact profiles. Palatal coverage of the maxillary overdentures was reduced at the first annual recall.

Results: Data showed significant improvement in pain reduction, comfort, stability, and function variables of the visual analogue scale after treatment. Analysis by prosthodontic design using visual analogue scale showed no significant difference. The total oral health impact profile-14 scores after treatment for all participants, regardless of prosthodontic design, were significantly lower (more satisfied). The overall oral health impact profile-20E score at baseline was significantly higher (more satisfied) compared with pre-treatment conventional maxillary dentures. No significant changes were observed in the first or second years compared with baseline results. Twenty-two participants (84.6%) preferred reduced palatal coverage, regardless of prosthodontic design, after 1 year. Twenty participants (76.9%) still preferred reduced palatal coverage at the end of the second year.

Conclusions: The provision of maxillary 3-implant overdentures to oppose mandibular 2-implant overdentures significantly improve levels of patient satisfaction compared with conventional maxillary dentures.

KEY WORDS: attachment systems, maxillary implant overdentures, patient satisfaction

INTRODUCTION

Review of the literature on patient satisfaction with maxillary implant overdentures, opposing mandibular 2-implant overdentures, reveals limited information. The majority of clinical studies on maxillary implant overdentures, using different prosthodontic designs,[1] have commonly had either an intact dentition, conventional,

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or implant-supported fixed prostheses in the mandible.[2–5] Therefore, accepted treatment philosophies for maxillary implant overdentures have evolved with a preference for a minimum of four to six implants.[5–9]

Patients accepting treatment recommendations of a mandibular 2-implant overdenture[10] may also wish to simultaneously have a maxillary implant overdenture to resolve their edentulous predicament.[11] This would avoid the pitfalls of advanced maxillary ridge resorption and the need for more complex interventions later.[12–15] There is no literature to support that patients wearing mandibular 2-implant overdenture must have four to six maxillary implants for a planned maxillary overdenture, as opposed to as few as three maxillary implants.[16] More so, research on patient satisfaction with maxillary overdentures on less than four implants, opposing mandibular 2-implant overdentures, is still lacking.

The Oral Health Impact Profile (OHIP) in different versions has gained recent popularity and acceptance as an improved measure of oral health status in population-based studies compared with visual analogue scales (VAS), categorical scales, or Likert-type scales.[17–19] The OHIP-49 captures seven conceptually formulated domains that cover a wide range of possible oral health problems impacting on quality of life. It shows good potential for use as an outcome measure in clinical trials, where conventional denture and mandibular 2-implant overdenture treatments for edentulous patients are compared.[17,20,21]

Allen and Locker[17] used a modified, shortened 19-item version of the OHIP for edentulism (the OHIP-EDENT) and found it as effective as OHIP-49. They concluded that it could be an appropriate measure for use in clinical settings with edentulous patients. The OHIP-EDENT also contains questions from each of the OHIP's seven conceptual domains (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap). Awad and colleagues[21] found significant improvement in oral health-related quality of life, measured with the OHIP-49 and OHIP-EDENT, in patients treated with mandibular implant overdentures in comparison to a group treated with conventional complete dentures. Another modified version, the OHIP-14,[18] accounted for 94% of variance in the OHIP-49. It also contained questions from each of the seven conceptual domains of the OHIP-49 and displayed the same pattern of variation among different sociodemographic groups of older adults. Currently, no studies have reported on the use of a modified OHIP for evaluating levels of patient outcomes with maxillary 3-implant overdentures opposing mandibular 2-implant overdentures.

The aim of this research was to evaluate the following hypotheses:

1. For patients with mandibular 2-implant overdentures, either splinted or unsplinted maxillary 3-implant overdentures would increase satisfactions levels compared with conventional maxillary dentures.
2. Patients with maxillary 3-implant overdentures would have a preference for reduced palatal coverage rather than full palatal coverage, regardless of the prosthodontic design (splinted or unsplinted).

MATERIALS AND METHODS

Patient Sample

Forty edentulous participants (mean age 63.8 years; SD 8.2) with conventional maxillary dentures opposed by mandibular 2-implant overdentures, who were part of the Oral Implantology Research Group, School of Dentistry, University of Otago, New Zealand, accepted an offer of inclusion in a further randomized clinical trial. Ethical approval was obtained from the Lower South Ethics Committee, New Zealand. The inclusion criteria required participants to be edentulous in the maxilla, and to have been successfully wearing their mandibular 2-implant overdenture for at least 3 years. Exclusion criteria included patients with Lekholm and Zarb Type E maxillae.[16] Using a table of random numbers, the participants were randomly allocated, with maximum concealment, to one of two similar implant systems (Brånemark System®, NobelBiocare, Göteborg, Sweden; Southern Implant System®, Southern Implants, Irene, South Africa).

Three roughened surface screw-shaped narrow-diameter titanium implants (Brånemark 3.3 mm; Southern Implants, 3.25 mm) were placed in 39 of original 40 participants (one participant was excluded as a result of unsuccessful surgery). From a total of 117 implants placed, 34 were 10 mm in length, 17 were 11.5 mm, 15 were 13 mm, and 51 were 15 mm in length. Therefore, the majority of participants had good bone.[16] Among the 117 implant sites, nine sites had Lekholm and Zarb bone quantity Type A bone; 45 sites had Type

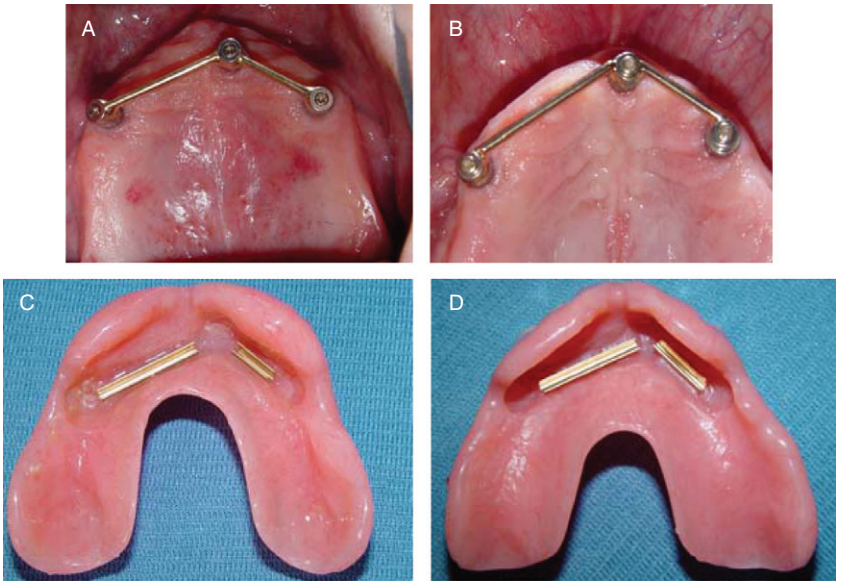

Figure 1 *A*, Micro-U-shaped bar patrices (Brånemark); *B*, micro-U-shaped bar patrices (Southern); *C*, bar clip (matrices) in overdenture (Brånemark); *D*, bar clip (matrices) in overdenture (Southern).

B, 42 sites had Type C bone, and 21 sites had Type D bone.[16]

Prosthodontic design (splinted group or unsplinted group) of the maxillary overdentures with each of the two implant systems was determined by further random allocation onto groups of 20 participants each. For the splinted prosthodontic designs, either standard abutments (Southern) or multi-unit abutments (Brånemark) were used. These were fitted with corresponding gold cylinders and two micro-U-shaped gold bars without distal extensions with corresponding gold matrices (DCA512; NobelBiocare, Goteborg, Sweden; Figure 1). For the unsplinted designs, ball abutments were used with gold matrices (DCA 532, Brånemark; ZZA1201A Antwerp, Southern Implants; Figure 2). Using the participants' current occlusal vertical dimensions and the existing complete maxillary dentures, a closed-mouth reline impression was made to include the

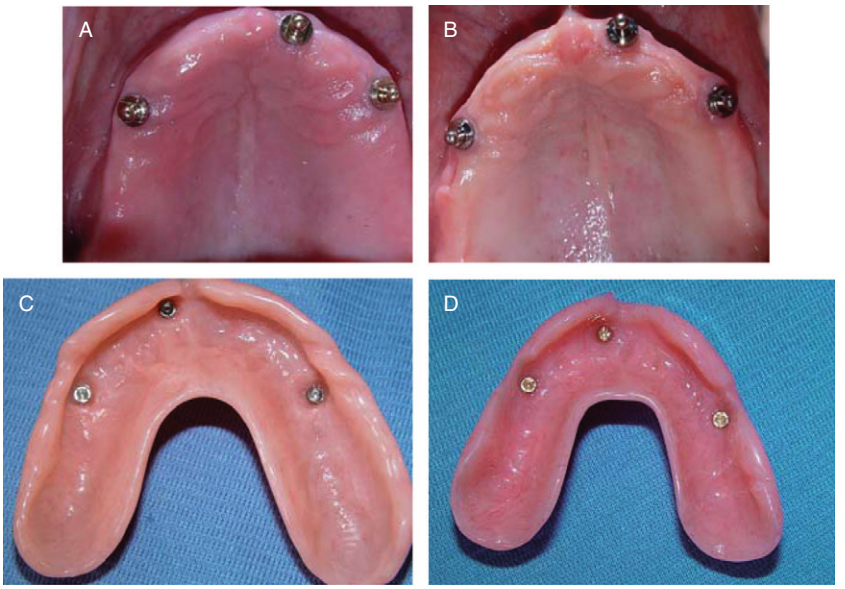

Figure 2 *A*, Maxillary ball patrices (Brånemark); *B*, maxillary ball patrices (Southern); *C*, gold matrices and overdenture (Brånemark); *D*, gold matrices and overdenture (Southern).

respective matrices for both prosthodontic designs. The participants wore the maxillary 3-implant overdentures with full palatal coverage only for the first year, and then with reduced palatal coverage for the subsequent year (Figures 1 and 2).

Questionnaires

Participants completed a series of questionnaires at baseline, time of maxillary 3-implant overdenture placement, and then after 1 and 2 years of wearing the maxillary 3-implant overdentures. The questionnaires were VAS, an OHIP-20 questionnaire, and an OHIP-14 questionnaire. A total of 39 participants completed the pre-treatment and baseline questionnaires followed by 35 at the 1-year recall, and 26 at the two-year recall as a result of implant failures, participant deaths, or drop-outs.

VAS makes use of a 10 cm straight line with right and left ends representing 100% satisfaction and 0% satisfaction, respectively.[22] By placing an X mark across the VAS scale, participants were asked to rate pain, comfort, appearance, function, stability, speech, cleaning difficulty, and overall satisfaction with their conventional maxillary dentures, maxillary implant overdentures, and mandibular 2-implant overdentures separately.[22]

The OHIP (OHIP-14 questionnaire)[18] was also used to evaluate functional limitation, pain, psychological discomfort, social disability, psychological disability, physical disability, and general satisfaction. The OHIP-14 uses a scale with five categories (1 = never, 2 = hardly ever, 3 = occasionally, 4 = fairly often, and 5 = very often). A lower score in any of the five categories indicates higher satisfaction.

In addition, the OHIP (OHIP-20E; OHIP-EDENT questionnaire)[19,23,24] was also used to elicit response on functional limitation, pain, psychological discomfort, psychological disability, physical disability, social disability, and general satisfaction. The OHIP-20 uses a scale with six categories (1 = always, 2 = most of the time, 3 = some of the time, 4 = occasionally, 5 = rarely, and 6 = never). The higher the score in any category, the more the participant is satisfied.

Interviews

Patients were interviewed after each annual recall with regard to their preferences on the full or reduced palatal coverage of their maxillary 3-implant overdentures.

Statistical Analysis

Group mean scores for each of the VAS items were calculated, and then difference among groups were tested for statistical significance using independent samples *t*-tests (for inter-group differences) or paired *t*-tests (for intra-group changes over time). Similar analysis will be calculated with modified OHIP scores, where appropriate levels of statistical significance were set at $p \leq .05$.

RESULTS

Quantitative Data

Analysis of the data of the VAS after insertion of the maxillary 3-implant overdenture showed significant improvement in the pain reduction, comfort, stability, and function variables at the baseline compared with pre-treatment conventional maxillary dentures (Table 1). The parameter of stability showed consistent significant differences up to 2 years. The range of VAS scores across the 10-cm scale were 7.30–8.63 cm (SD range 0.22–2.56 cm). Analysis by prosthodontic design using VAS scale showed no significant difference in all the variables. No statistical significant changes between the first and second years were found. There was a significant improvement only in speech at the second year recall compared with pre-treatment data. The opposing mandibular 2-implant overdenture patient ratings showed significant improvement only in the comfort and stability variable at the second year ($p < .02$).

Analysis of the pre- and post-treatment data for OHIP-14 is detailed in Table 2, along with the changes from baseline to second year for both treatment groups. With all participants combined together, regardless of the prosthodontic design, they had significantly lower (more satisfied) total OHIP-14 scores, as well as significant differences in all the seven subscales from pre-treatment to baseline. Although no significant changes were observed after year 1 or 2 in comparison to baseline, data showed that participants still scored lower (more satisfied), irrespective to their prosthodontic design. When analyzed by prosthodontic design (splinted and unsplinted groups), pre-treatment analysis of the data showed significant differences in social disability and handicap subscales only ($p < .02$, $p < .04$, respectively) in the unsplinted group (ball attachment) compared with splinted (bar attachment) group. Statistically significant differences at baseline were found in previous social disability and

TABLE 1 *p*-Value Comparison: Patient Satisfaction with Visual Analogue Scales

	Before Baseline	Before through to First Year Recall	Before through to Second Year Recall	Baseline to First Year Recall	Baseline to Second Year Recall	First Year to Second Year Recall
Maxillary 3-implant overdenture						
Pain	0.02*	0.001	0.14	0.10	0.93	0.16
Comfort	0.04*	0.001	0.001*	0.03*	0.06	0.08
Appearance	0.89	0.25	0.32	0.14	0.37	0.59
Function	0.01*	0.01	0.05	0.53	0.80	0.45
Stability	0.001*	0.001*	0.001*	0.78	0.01	0.60
Cleaning	0.91	0.74	0.11	0.19	0.96	0.13
Satisfaction	0.15	0.05	0.09	0.09	0.07	0.36
Mandibular 2-implant overdenture						
Pain	0.18	0.62	0.45	0.88	0.70	0.86
Comfort	0.23	0.07	0.85	0.04*	0.53	0.02*
Appearance	0.03	0.22	0.55	0.27	0.04	0.08
Function	0.17	0.21	0.98	0.36	0.45	0.24
Stability	0.29	0.44	0.45	0.26	0.06	0.02*
Cleaning	0.37	0.66	0.86	0.44	0.61	0.28
Satisfaction	0.58	0.75	0.78	0.81	0.39	0.21
Speech	0.08	0.34	0.05*	0.21	0.84	0.25

*Significant differences.

handicap subscales in the unsplinted group ($p < .03$, $p < .01$, respectively); however, no significant changes were found between the two groups at first and second year, respectively.

Analysis of the data for all participants showed that the overall OHIP-20 score at baseline was also higher (more satisfied); however, no significant changes were observed in the first or second year compared with baseline results (Table 3). Significant improvements at baseline were observed in three subscales; functional limitation, pain, and physical disabilities. Analysis of the data by prosthodontic design using the OHIP-20 at baseline showed a statistically significant difference (improvement) in the handicaps subscale in the unsplinted group (ball attachment) ($p < .04$) compared with the splinted group (bar attachment). No statistical differences at first and second year results between the two groups were observed.

TABLE 2 Mean OHIP-14 Total and Subscale Scores

OHIP-14	Pre-treatment	Baseline	Year 1	Year 2
Overall OHIP-14 score	26.76 (9.93)	19.61 (5.01)[a]	19.60 (5.60)	18.84 (5.02)
Subscale scores				
Functional limitation	4.46 (2.00)	3.19 (1.13)[b]	3.19 (1.38)	2.84 (0.88)
Physical discomfort (pain)	4.88 (1.72)	3.11 (1.33)[c]	3.23 (1.21)	3.15 (1.04)
Psychological discomfort	3.96 (1.75)	3.00 (1.32)[d]	2.80 (1.20)	2.57 (0.90)
Physical disability	3.96 (1.75)	3.15 (1.00)[e]	2.96 (0.95)	3.07 (1.09)
Psychological disability	3.65 (1.74)	2.61 (1.02)[f]	2.69 (1.15)	2.69 (0.92)
Social disability	3.07 (1.29)	2.30 (0.67)[g]	2.46 (0.85)	2.26 (0.87)
Handicap	2.76 (1.24)	2.23 (0.65)[h]	2.32 (0.62)	2.23 (0.65)

[a]$p \le .001$, [b]$p \le 0.005$, [c]$p \le .001$, [d]$p \le .01$, [e]$p \le .03$ [f]$p \le .007$, [g]$p \le .01$, [h]$p \le .03$ (for pre-treatment/baseline change).
Note: OnOHIP-14 scale a lower score means participants are more satisfied.

TABLE 3 Mean OHIP-20 Total and Subscale Scores

OHIP-20	Pre-treatment	Baseline	Year 1	Year 2
Overall OHIP- 20 score	89.69 (16.04)	99.76 (16.82)[a]	99.76 (17.07)	99.92 (17.17)
Subscale scores				
Functional limitation	11.53 (3.37)	13.80 (2.78)[b]	13.42 (2.61)	13.88 (3.05)
Physical discomfort (pain)	17.96 (4.55)	20.23 (4.25)[c]	20.38 (3.99)	20.32 (3.90)
Psychological discomfort	9.65 (1.93)	10.50 (1.96)	10.61 (2.60)	10.96 (2.04)
Physical disability	13.57 (3.25)	16.19 (2.96)[d]	15.88 (3.07)	15.73 (3.40)
Psychological disability	9.53 (1.98)	10.50 (2.30)	10.61 (2.40)	10.76 (2.00)
Social disability	16.69 (2.01)	17.07 (2.79)	17.38 (2.94)	17.03 (3.02)
Handicap	10.73 (1.99)	11.46 (1.79)	11.46 (1.96)	11.46 (2.00)

Note: On OHIP-E20 scale a *higher* score means participants are more satisfied.
[a]$p \le .02$, [b]$p \le .02$, [c]$p \le .05$, [d]$p \le .003$ (for pretreatment/baseline change).

Overall, participants did not report any improvement in speech using their maxillary 3-implant overdentures at baseline compared with pre-treatment conventional maxillary dentures. Also, there was no significant difference in speech with full or reduced palatal coverage designs between the first and second year.

Overall, when considering all the subscales of OHIP-14 and OHIP-20, the two groups (splinted and unsplinted) showed no statistically significant changes in pre-treatment, baseline, and up to the second year.

Qualitative Data

From the 26 participants presenting for the 2-year recall, all had been provided with full palatal coverage design at baseline. During the interviews, 22 participants (84.6%) preferred reduced palatal coverage, regardless of the prosthodontic design after 1 year. Four (15.4%) participants, on the other hand, still preferred full palatal coverage. After the end of the second year of wear, 20 participants (76.9%) still preferred reduced palatal coverage of their prostheses compared with six participants (23.1%) having preference for full palatal coverage. Of these six participants, two were from the splinted group and four were from the unsplinted group. The 20 participants that preferred reduced palatal coverage did not subjectively report that retention had been affected by reducing the palatal coverage. Participants that preferred reduced palatal coverage revealed greater pleasure with the exposed palate in the experience of eating food and drinking beverages.

DISCUSSION

This research aimed to determine levels of patient satisfaction with maxillary 3-implant overdentures opposing mandibular 2-implant overdentures. Two different prosthodontic designs (splinted and unsplinted) were used, which were both mucosa and implant supported. Levels of patient satisfaction improved with maxillary 3-implant overdentures were improved compared with their conventional maxillary dentures. There were no differences in the patient ratings between the splinted and unsplinted prosthodontic designs for maxillary 3-implant overdentures.

Patient outcomes with different treatment approaches using oral implants in the edentulous maxilla for overdentures are controversial in the prosthodontic literature. This is compounded by the differing number of maxillary implants used to support the overdentures. Zitzmann and Marinello,[5] using VAS, found no significant differences in the levels of patient satisfaction (related to comfort/retention, function, aesthetics, taste, speech, or self-esteem) between maxillary implant overdentures on six to eight implants and maxillary fixed implant bridges on 8–10 implants. In a cross-over trial,[6] 13 edentulous patients were treated with maxillary implant overdentures or implant-fixed bridges supported by four to six implants. Psychometric measurements of general satisfaction as well as comfort, ability to speak, stability, aesthetic, ease of cleaning, and occlusion were obtained once each prosthesis had been worn for 2 months. Majority of patients were significantly satisfied with the maxillary implant overdentures than with the maxillary fixed implant bridges. Drawing

conclusions and comparing results from these two aforementioned studies is difficult because of differences in study designs and different degrees of support form different numbers of implants. The findings of Heydecke and colleagues[6] are in agreement with those reported by Kaptein and colleagues[25] on 88 patients treated with maxillary bone reconstruction in combination with implant overdentures and fixed bridges. Patient satisfaction with treatment outcomes was measured using a five-point scale (1 = bad/few, 5 = very good/much) and 56 questions grouped into seven categories: history of referral, post-operative surgical experiences, hygiene, prosthetic experiences, result expectations, satisfaction, and patient's motivation for going through the treatment. The study findings identified 80% of the patients accepting the prosthodontic design of maxillary overdentures supported by six implants. Others using VAS[26] or nine-point scales,[7] also reported marked improvement in the level of patient satisfaction after the first year of treatment with splinted prosthodontic designs for maxillary implant overdentures. In another study, Raghoebar and colleagues[15] assessed the level of patient satisfaction using validated questionnaire for 72 patients treated with maxillary six-implant overdentures. Of the 72 patients, 21 had opposing mandibular implant overdentures while the rest had conventional or partial dentures. Overall, the patients were satisfied with their prosthodontic rehabilitation after an average of 5 years. The results were comparable to that of Kaptein and colleagues[25] where a similar prosthodontic design was used (maxillary 6-implants overdentures). However, the state of the opposing arch and assessment scales were different in the two studies.

Direct comparison of our research findings with those reported in other studies is difficult because of the uniqueness of the maxillary 3-implant overdenture design we used. One study[27] on 13 patients reported no significant difference in patient satisfaction between maxillary 4-implant bar overdentures and conventional maxillary dentures. The authors questioned the advantage of using maxillary implant overdentures for patients with limited residual ridge resorption. These findings are in apparent contrast to the present study where significant improvement in patient satisfaction with maxillary 3-implant overdentures was observed. The different conclusions reached, could have resulted from differences in the severity of maxillary residual ridge resorption in the two studies or the smaller sample size used in the study of de Albuquerque and colleagues,[27] resulting in a possible type II error.

Reducing palatal coverage of maxillary implant overdentures has been described in controlled clinical trials, but never in patients with as few as 3 maxillary implants.[5,6,27,28] The rationale for reduced palatal coverage relates to exposure of certain anatomical features of the palate (minor salivary glands and sensory innervations) resulting in less speech disturbance, improved eating sensation and a reduction in the bulk of the maxillary overdenture. Our informal interviews with participants disclosed that the majority, but not all, patients had a preference for reduced palatal coverage. This appeared to be their incentive for proceeding with the additional intervention.

The reduction of the palatal coverage of the maxillary 3-implant overdentures did not seem to bear significant influence on speech compared with pre-treatment conventional maxillary dentures in the first year. Similar observation was also noted in the study of Heydecke and colleagues.[28] However, in the second year of our study, a significant improvement in speech ($p < .05$) with reduced palatal coverage design was observed compared with pre-treatment. This could have resulted from the gradual improvement in patient confidence and the significant improvement in the psychological wellbeing and social function. Therefore, the participants perceived that their ability to speak was improved.

De Albuquerque and colleagues,[27] assessed patient outcomes of 13 participants provided with splinted maxillary 4-implant overdentures with and without palatal coverage opposing mandibular fixed implant bridges. VAS and categorical scales were used in the assessment. Patient rating with the maxillary 4-implant overdentures did not differ significantly from baseline with conventional maxillary dentures. Reducing the palatal coverage also did not bring significant improvement in the level of satisfaction compared with full coverage. Zitzmann and Marinello[5] using VAS compared maxillary bar implant overdentures with fixed implant bridges in 10 patients, all with reduced palatal coverage. Significant improvement in comfort and retention, function, aesthetics and appearance, taste, speech, and self-esteem was observed with both treatments without significant differences. On the other hand, significantly high ratings of general satisfaction with bar attachment maxillary implant overdentures in comparison to fixed

implant bridges also using VAS was reported.[6] The authors also found a significant preference related to speech and ease of cleaning with the maxillary implant overdentures. In a cross-over trial,[28] it was observed that patients produced more intelligible speech with maxillary implant overdentures than with implant fixed bridges. It was further observed that more speech problems were evident in patients originally planned for a fixed prosthesis than in those planned for overdenture treatment.[29] To minimize the risk of speech problems, the authors in that study[29] recommended special attention to be given to the design of the new denture, making it as identical as possible to the previous one. It should be noted that none of these trials[6,28,29] used maxillary implant overdentures with unsplinted prosthodontic design and reduced palatal coverage. Furthermore, the prosthesis in the opposing arch were not standardized having either mandibular fixed implant bridges, mandibular 2- or 4-implant overdentures or even natural dentition.

CONCLUSIONS

1. The provision of a splinted or unsplinted maxillary 3-implant overdenture to oppose a mandibular 2-implant overdenture will improve levels of patient satisfaction compared to a conventional maxillary denture.
2. There were no differences in the patient ratings of a splinted prosthodontic design as compared to an unsplinted one for maxillary 3-implant overdentures.
3. Not all patients will prefer reduced palatal coverage of their maxillary 3-implant overdenture, regardless of prosthodontic design.

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