A Within-Subject Comparison of Patient Satisfaction and Quality of Life Between a Two-Implant Overdenture and a Three-Implant–Supported Fixed Dental Prosthesis in the Mandible

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Purpose: This within-subject comparison tested the null hypothesis that there is no difference in patient satisfaction and oral health–related quality of life when an individual with an edentulous mandible is rehabilitated with a two-implant overdenture or a three-implant–supported fixed dental prosthesis. Materials and Methods: Twelve subjects with an edentulous mandible or failing dentition were rehabilitated with the use of endosseous dental implants. Three implants were placed, and were immediately loaded with a provisional fixed prosthesis with minimal cantilever. After healing for 4 months, two Locator attachments were inserted and an overdenture was trialed; then, after a further 4 months, a fixed prosthesis was placed on the three implants. The fixed prosthesis was fabricated using computer-assisted design, and a titanium framework was manufactured with a resin base and teeth. Patient satisfaction and oral health–related quality of life was assessed before treatment, after wearing the provisional, and after each treatment option using a seven-item visual analog scale and a modified version of the 49-item oral health impact profile. Results: Of the 12 subjects, 11 chose the fixed over the removable prosthesis. A statistically significant (P < .05) and positive effect on the overall score of both assessment tools was reported for both treatment modalities (when compared with pretreatment scores). Although no significant difference (P > .05) was found between the two options in overall scores of both surveys or in any of the seven domains of the modified oral health impact profile, the fixed prostheses had a statistically higher score for stability, retention, and ease of chewing on a visual analog scale. Conclusion: Both treatment modalities provided a significant and similar improvement in patient satisfaction and oral health–related quality of life compared with a conventional complete mandibular removable dental prosthesis; however, a statistically significant higher score was reported for stability, retention, and ease of chewing for the fixed dental prostheses. Based on the 12 participants in this study, greater stability and ease of chewing with the fixed prostheses likely influenced patient preference in most but not all subjects. Int J Oral Maxillofac Implants 2018;33:1374–1382. doi: 10.11607/jomi.6666

Keywords: fixed, implants, mandible, overdenture, patient satisfaction, quality of life, removable

Although the rate of total edentulism in developed nations has continued to decline with each decade, there remains a substantial number of afflicted adults as a result of population growth and increasing lifespan.¹,² Edentulism is a chronic condition that may lead to significant reduction in quality of life. It has been reported that masticatory efficiency for an individual with a conventional complete removable dental prosthesis (RDP) or denture is 1/6th of dentate subjects.³ Although conventional complete maxillary RDPs have been reasonably effective in improving function and esthetics, many people are unable to cope with a complete mandibular RDP.⁴ There is less surface area for load distribution and limited adhesive and retentive forces. During function, lip and cheek muscle movement can further destabilize a complete mandibular RDP.⁵ This is often exacerbated by advanced bone resorption,

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xerostomia, loss of keratinized tissue, and neuromuscular degeneration.6

Contemporary practice provides alternatives for patients who cannot cope with a conventional complete mandibular RDP. Alternatives may involve an improved impression technique7 or resilient lining; however, the best options involve the use of endosseous dental implants. Dental implants have been used successfully for rehabilitation of the edentulous mandible since the biologic development of osseointegration; the first mandibular implant case was in 1965 by Professor Per-Ingvar (P.I.) Brånemark and the first international report in 1981.8 Implant use is particularly valuable in older patients, whose chief complaints often relate to discomfort, instability, and lack of retention of their appliances.9

Implants can be used to retain and/or support different types of prostheses. These can be broadly categorized as removable such as an implant overdenture or an implant-supported fixed dental prosthesis (FDP) with no tissue support.

The two-implant overdenture was proposed by consensus as the first-choice standard of care for the edentulous mandible.10 There is substantial evidence that as a group, such patients are more satisfied and have significantly improved quality of life over a new conventional complete mandibular RDP.11 This treatment option may not suit individuals who prefer a fixed appliance or who psychologically cannot cope with an RDP. Individuals often perceive a fixed prosthesis as part of their own body, offering a psychologic advantage.12 Patients with sensitive mucosa or high retention and stability needs may find the treatment less satisfying13 or be dissatisfied.14

An international survey of prosthodontists by Kronstrom and Carlsson (2017)15 reported that lower cost of an overdenture on two implants was a principal component of the decision-making process for choosing an overdenture over an implant-supported FDP; prosthodontists surveyed reported that their patients were equally (57%) or more satisfied (37%) with an implant-supported FDP. Fixed prostheses in the mandible have been shown to offer improved general satisfaction and chewing ability.16 It is accepted that cost is in general higher with a fixed restoration, and hygiene more difficult.

If cost was not a factor, an implant-supported FDP is likely to be preferred. Cost reduction is possible with fewer implants17 and using digital technology to manufacture the framework.

The aim of the present pilot study was to evaluate patient satisfaction with a two-implant overdenture and a three-implant–supported FDP, and to test the null hypothesis that there is no difference in satisfaction between these two options.

### MATERIALS AND METHODS

This study aimed to investigate outcomes of oral rehabilitation of individuals with an edentulous mandible with the use of dental implants. All participants compared a two-implant overdenture and a three-implant–supported FDP. The study primarily measured patient satisfaction and oral health–related quality of life, but also recorded implant health and survival, and prosthetic complications. The investigation was approved by the Human Research Ethics Committee (HREC) at the University of Sydney (USYD), Australia (Reference: 2015/528). The study was undertaken in a private practice.

### Patient Screening and Enrollment

The general public was made aware of the study principally using a local radio station. Those interested were invited to attend an initial screening, where a complete history was taken and an oral examination was performed to ensure that inclusion criteria and no exclusion criteria were met in Table 1.

### Table 1  Inclusion and Exclusion Criteria of the Study

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
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<tr>
<td>Fluent in English</td>
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<td>Above the age of 18</td>
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<td>Willingness to provide informed consent</td>
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<td>Good physical health – American Society of Anaesthesiologists (ASA) Class I or II</td>
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<td>Edentulous in the mandible or presenting with few mandibular teeth with a poor prognosis</td>
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<td>Adequate quality and sufficient volume of bone in the parasymphyseal region of mandible to place three dental implants with a minimum length of 10.0 mm and diameter of 4.0 mm</td>
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<tr>
<th>Exclusion criteria</th>
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<tr>
<td>Pregnancy or a desire to become pregnant during the expected duration of the study</td>
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<tr>
<td>Bad physical health – ASA Class III, IV, V or VI</td>
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<td>Uncontrolled diabetes</td>
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<td>Subjected to irradiation in the head or neck region</td>
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<td>Substance abuse</td>
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<td>Smoking habit</td>
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<td>Severe bruxism</td>
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<td>Unrealistic expectations</td>
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<td>Psychologic problems for accepting a RDP (such as a severe gag reflex)</td>
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<td>Medications that may impair normal healing ability (such as coagulation)</td>
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<tr>
<td>Any other condition that may contraindicate dental implant therapy</td>
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Surgical Planning and Preparation
A new prosthesis was made for those patients who did not have an existing or adequate conventional complete mandibular RDP.

A clear resin copy was made with gutta-percha (GP) markers as reference points of the complete mandibular RDP, or for partially dentate patients, the trial setup. Three-dimensional cone beam computed tomography (3D CBCT) was performed with the guide inserted during the scan. The radiographic guide was subsequently converted into a surgical guide by carefully placing three channels at planned positions.

Surgical Phase
Extraction of failing teeth, alveoloplasty for adequate restorative space, and implant placement was performed by a single practitioner (D.B.) (who performed the surgical and restorative phase of treatment) using local anesthesia with buccal and lingual infiltration, without sedation.

The implants placed in each patient included:

- A Nobel Biocare (USA) Replace Conical Connection (CC) Partially Machined Collar (PMC) implant with a minimum diameter of 4.3 mm on each side of the mandible, close to and anterior to the mental foramen. These implants were not intentionally angulated distally.
- A Nobel Biocare (USA) Replace Select (RS) Tri-Channel implant with a diameter of 4.0 mm at the mandibular midline

The length of the implants varied from 10.0 to 16.0 mm. The longest implant allowable was chosen. Following implant placement, a nonangulated multi-unit abutment with a height of 3.5 mm was attached to the Nobel Biocare CC PMC implants. An abutment was not required for the Nobel Biocare RS TC implant. This midline implant allows a larger abutment screw to be direct to the implant, providing greater preload and reducing the risk of screw loosening. When loading the distal cantilevers, the distal implants experience the greatest stress at bone level, and the midline retention screw experiences the highest loading in tension. The Replace Conical Connection implant was chosen for the higher primary stability provided by the tapered body at the distal implants.

After the mucoperiosteal flap was closed, a provisional prosthesis was made by modifying the conventional complete mandibular RDP and inserted. Temporary cylinders manufactured by Nobel Biocare were united to the prosthesis using light curing resin, and the prosthesis was reduced to a 10-unit provisional, without molar units or metal reinforcing, and polished prior to fitting (Figs 1, 2, and 3).

Prosthodontic Phase
Two different prostheses were trialed: first, a two-implant overdenture, and second, a three-implant-supported FDP. The overdenture and FDP were each manufactured with 12 occlusal units, of the same tooth mold and position.

Overdenture
After 4 months of healing following implant placement and use of the fixed provisional, a new mandibular implant overdenture was fitted: this was the first prosthesis to be assessed. Only the two distal implants were used to retain the prosthesis. The multi-unit abutments remained connected during the impressions, so that implant locations could be identified.

At the time of insertion, the provisional mandibular FDP was first removed by disconnecting the temporary cylinders, and the multi-unit abutments were then disengaged. Subsequently, a cover screw was fastened to the symphyseal implant, and a Zest Anchors Locator R-Tx attachment system with a height of 4.0 mm was screwed into each of two distal implants (Fig 4).

A metal attachment housing was then bonded into the prosthesis intraorally. GC Fit Checker was used to confirm that there was no rotation contact of the prosthesis with the cover screw fastened to the implant in the mandibular midline. Figure 5 is an example of a completed two-implant overdenture.
After 4 months of use, the overdenture was removed, and a three-implant–supported FDP was made. Initially, a clear copy of the overdenture was made. The Locator attachments were removed, multi-unit abutments were reattached, and impression copings were connected to the abutments. The copy was seated on the tissues, and minor adjustments were made to allow a comfortable and passive fit around the impression copings; these were joined to the clear replica with pattern resin (Fig 6). This was then disconnected, the multi-unit abutments were removed, and Locator abutments were re-inserted along with the mandibular RDP.

A negative impression of the teeth was made to ensure that the arrangement of the FDP closely resembled the RDP. This was scanned using Nobel Biocare Procera, which allowed design and then manufacture of a custom titanium milled framework (Fig 7). Once the framework was milled, a diagnostic wax-up was attached, and the negative index was used to confirm the close arrangement to the RDP. The milled frame and wax-up was fitted to evaluate occlusal vertical dimension, esthetics, phonetics, and centric relation. All modifications were made at this stage. The appliance was processed, polished, and inserted (Fig 8), and worn for 4 months.

**Evaluation**

**Patient Satisfaction.** Patient satisfaction was evaluated using a self-administered seven-item visual analog scale (VAS). The tool was used to assess comfort, ease of speaking, ease of cleaning, esthetics, stability, retention, and ease of chewing. Patients were asked to indicate on a 10-cm line, with zero referring to poor outcome and 10 corresponding to excellent outcome. No weightings were used. Patients were asked to complete this tool before treatment commenced and after each treatment option was trialed for 4 months.

**Oral Health–Related Quality of Life.** Oral health–related quality of life was measured using a modified version of the 49-question Oral Health Impact Profile (mOHIP-49) developed by Awad et al (2008) to better suit edentulous patients. The questionnaire captures seven domains: functional limitation, physical pain, psychologic discomfort, physical disability, psychologic disability, social disability, and handicap. It has a six-point scale: 1–never, 2–rarely, 3–occasionally, 4–some of the time, 5–most of the time, and 6–all of the time. Patients were asked to complete this tool before treatment commenced and after each treatment option was trialed. No weightings were used.

**Selected Prosthesis**

At the conclusion of the study, each patient was asked to select their preferred prosthesis.

**Implant Survival**

Implants were examined for discomfort or mobility. Additionally, the implants were examined for peri-implant suppuration; probe pocketing depth greater than 5.0 mm; or radiographic bone loss greater than 3.0 mm from the rough surface of the implant-abutment interface.

**Prosthetic Complications**

The primary investigator tabulated prosthetic complications by means of a review of attendance records.
Possible prosthetic complications included: abutment or prosthetic screw loosening, adjustments, repairs, and relines.

Statistical Analysis
Demographic characteristics, implant survival, and prosthetic complications were analyzed by using descriptive tabular methods. The paired t test was used to compare the mean scores of the seven-item VAS and mOHIP-49 for the two treatment options. The test was also used to compare pre- and post-treatment scores.

RESULTS

Candidate Enrollment
Twelve subjects were recruited for the study, which included five men and seven women, varying in age from 60 to 81 years with a mean ± SD age of 69 ± 6.46 years. There was no difference in the pretreatment demographic characteristics in terms of age, sex, or dental status of the maxilla or mandible. Eight were edentulous in the maxilla and five in the mandible.

Patient Satisfaction
Table 2 shows the mean scores and standard deviation for each of the seven items before treatment, and after each treatment option was trialed. The results are also shown graphically in Fig 9. The error bars in Fig 9 refer to the two-tailed 95% confidence interval.

Apart from cleaning, mean scores for all items were lower before treatment than after the provisional or either treatment modality. For ease of cleaning, the mean score was lower for the provisional and fixed, but higher for removable. A paired t test test revealed that there was a significant difference ($P < .05$) between before treatment and after implant placement with

<table>
<thead>
<tr>
<th>Item</th>
<th>Before treatment</th>
<th>Provisional</th>
<th>Removable</th>
<th>Fixed</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Comfort</td>
<td>3.8</td>
<td>2.5</td>
<td>7.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Ease of speaking</td>
<td>6.9</td>
<td>2.9</td>
<td>8.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Ease of cleaning</td>
<td>7.5</td>
<td>3.2</td>
<td>6.4</td>
<td>3.0</td>
</tr>
<tr>
<td>Esthetics</td>
<td>4.7</td>
<td>2.8</td>
<td>8.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Stability</td>
<td>2.5</td>
<td>2.9</td>
<td>9.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Retention</td>
<td>2.8</td>
<td>2.2</td>
<td>9.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Ease of chewing</td>
<td>3.8</td>
<td>3.2</td>
<td>6.8</td>
<td>3.4</td>
</tr>
<tr>
<td>Overall</td>
<td>31.9</td>
<td>12.6</td>
<td>56.6</td>
<td>10.1</td>
</tr>
</tbody>
</table>
the provisional, removable, and fixed scores for comfort, esthetics, stability, and retention. A significant improvement was only reported for ease of speaking and chewing for the fixed prosthesis. No statistically significant difference \((P > .05)\) was observed before treatment and after any treatment option in terms of ease of cleaning.

Although mean scores for all items apart from ease of cleaning were higher for fixed than removable, a statistically significant difference was only seen for retention, stability, and ease of chewing.

**Oral Health–Related Quality of Life**

Table 3 shows the mean scores and standard deviations for each of the seven domains before treatment, and after each treatment option. A lower score refers to a better treatment outcome. The results are also shown graphically in Fig 10. The error bars refer to the two-tailed 95% confidence interval.

The mean scores before treatment were higher than after the provisional and each treatment option across the seven domains. A paired \(t\) test revealed that differences were statistically significant for all domains apart from social disability and handicap. Marginal differences were observed in mean scores between both treatment options (as well as the provisional) across the seven domains. With the paired \(t\) test, there was no statistically significant difference in any of the seven domains.

**Selected Prosthesis**

At the end of the study, each patient was asked to select their preferred treatment. Of the 12 subjects, 11 chose the fixed option.

**Implant Survival**

At the conclusion of the study, all 36 implants survived, with all implants remaining functional and with no...
patient experiencing pain or tenderness in the region. However, one implant (at the midline) showed significant bone loss and bleeding on probing without suppuration.

**Prosthetic Complications**
Possible prosthetic complications recorded in this study included: abutment or prosthetic screw loosening, adjustments, repairs, and relines. Prosthetic complications were few. Unscheduled visits at the patients’ request addressed discomfort and insufficient retention.

Although two relines were made, these were only for maxillary prostheses when the patient complained about insufficient retention and stability.

The number of adjustment visits for two-implant overdentures were 30. Visits included adjustments of the intaglio surface to alleviate pressure spots, and change of the nylon retention inserts to optimize retention.

Only a small number of visits (5) were needed for the three-implant–supported FDPs, with two visits to replace or polish temporary material covering the prosthetic screw access channel and three visits to change the lingual contour to prevent irritation of the tongue.

**DISCUSSION**

There are few studies that have compared patient satisfaction between removable and fixed prostheses using implants for rehabilitation in the edentulous mandible. Those available show little difference in terms of patient satisfaction, quality of life, implant health, and survival. This study is different from others, as it is a within-subject comparison of a two-implant overdenture and a three-implant–supported FDP.

**Patient Satisfaction**

In this study, there was a significant improvement in patient satisfaction when rehabilitated with either prosthesis. This was shown by an improvement in at least four of the seven items on the VAS for either intervention. De Kok et al (2011) also showed very similar findings.

There was no statistically significant difference between the fixed and removable prostheses in terms of overall satisfaction, even though the mean overall scores were higher for fixed prostheses.

Esthetics is an important component of overall patient satisfaction. A significant difference in patient satisfaction for esthetics or ease of speaking was not expected, as tooth mold and shade were identical and the tooth position of the RDP was indexed to replicate the FDP. The inclusion of these domains may have reduced the ability of the assessment to identify a difference in overall satisfaction.

There was no significant difference for ease of cleaning, although the mean scores were higher for the removable than the fixed. Some patients did express a greater difficulty in cleaning their fixed prostheses. Data indicated that the FDP had a statistically higher score for stability, retention, and ease of chewing. This is important, especially with the small sample size, and has implications for study design, as several studies have shown that stability and chewing ability are the most important determinants in patient satisfaction with a conventional RDP and when given a choice, patients choose the more stable prosthesis.

The use of equal weightings in the VAS may not reflect the impact of each item for overall satisfaction.

**Oral Health–Related Quality of Life**

There was a significant improvement in overall quality of life with both prostheses (as indicated by overall scores on the mOHIP-49). This was also shown by the significantly lower scores in five of the seven domains.

Similar to the results from the VAS, mOHIP-49 results did not show any significant difference between the two treatment modalities for overall scores or in the seven domains.

The inability of mOHIP-49 to establish a significant difference may be due to the small sample size, as the mean score was lower in all domains for the FDP compared with the overdenture. The OHIP was designed to broadly measure the social impact of oral disorders. A failure of the study to detect a statistically significant difference does not necessarily demonstrate equivalence but may instead demonstrate the inability of the study to detect the importance as perceived by the patient.

**Prosthesis Selection**

At the conclusion of the study, 11 of 12 subjects chose the three-implant–supported FDP. This is in contrast to the within-subject study by Feine et al (1994), where the choice was nearly equal. Notably, the overdenture for comparison in the Feine et al (1994) study was supported by a long-bar with distal cantilevers and four implants.

The only subject to prefer an overdenture had impaired hand dexterity with two congenitally missing fingers and arthritis. Another subject was also contemplating choosing the removable, finding it difficult to clean due to impaired function from an accident. This subject, however, chose the FDP for better chewing ability. This may suggest that the FDP is not appropriate for subjects with impaired hand dexterity.
Implant Survival
A review by De Bruyn et al (2015) concluded that three implants are insufficient to support an FDP in the mandible with immediate loading; all of the studies included the use of machined surface implants and early or immediate loading with a full-arch FDP. The most common implant to fail was the distal implant supporting the cantilever, most failing within 1 year.

At the end of this short-term study, all 36 implants survived. A study published by De Kok et al (2011), with three implants immediately loaded with a tissue-supported and soft-lined RDP, followed by the FDP at 16 weeks, also reported a similar conclusion at 12 months. Both of these studies utilized rough surface implants, and were not immediately loaded with an implant-supported full-arch FDP.

As such, the findings provide some additional indication that three implants may be used to support a full-arch mandibular FDP when implants with surface modification and staged cantilever loading to reduce distal implant stress during early integration are used. Longer observation periods and randomized trials with three versus four implants would be helpful to validate this finding. The European Association of Osseointegration (EAO) third consensus conference in 2012 also encouraged this.

Prosthetic Complications
All prosthetic complications during the study were minor. This was expected, as each prosthesis was only worn for 4 months. No provisional fractured despite the lack of metal re-enforcing. The number of adjustment visits was substantially higher for the overdenture. Seven of the 12 patients were partially dentate prior to the study and were new to complete prostheses. They required more attention.

Limitations of the Study
The subject number was limited to 12. They were not randomized into two groups; that is, one group receiving the two-implant overdenture first with the other initially receiving the definitive three-implant-supported FDP. The effects of sequence bias on data validity are likely to be slight for two reasons.

First, as all subjects had as a baseline a fixed provisional prosthesis, the overdenture would be preceded by a fixed prosthesis in either case. Second, in the crossover study of 15 subjects by Feine et al (1994), there was no effect of the sequence of treatment (whether a subject was wearing the fixed prosthesis or the removable prosthesis at the last appointment) on choice or ratings made at the final appointment.

CONCLUSIONS
Within the limitations of this study, the following conclusions can be made. Both a two-implant overdenture and a three-implant-supported FDP provide a significant and similar improvement in patient satisfaction and oral health–related quality of life compared with a conventional complete mandibular RDP. A three-implant–supported FDP offered better stability, retention, and ease of chewing than a two-implant overdenture. Based on the 12 participants in this study, greater stability and ease of chewing with the fixed prosthesis likely influenced patient preference in most but not all of the subjects.

ACKNOWLEDGMENTS
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REFERENCES


