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Cost-effectiveness of three different concepts for the rehabilitation of edentulous mandibles: overdentures with 1 or 2 implant attachments and hybrid prosthesis on four implants

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ABSTRACT

\textbf{Background:} There is scarce data regarding the combined assessment of the costs and effects of implant treatments for edentulous patients when multiple options are available. \textbf{Aim:} This randomized clinical trial aimed to assess the cost-effectiveness of three different concepts for treatment: mandibular overdenture retained by a single (Group I; n=11) or two implants (Group II; n=13), and fixed hybrid prosthesis on four implants (Group III; n=13). \textbf{Methods:} Treatment effectiveness was measured as the 1-year before-after changes in patient satisfaction with the mandibular prosthesis. Costs were prospectively quantified from the perspective of the health provider, including all direct cost items attributed to the delivery of treatments and up to the 1-year follow-up, using a “bottom-up” costing estimation method. \textbf{Results:} Patient satisfaction after treatment improved significantly for the three groups. The overall costs were R$ 2,370.66, R$ 3,185.21, and R$ 5,739.52 for Groups I, II and III, respectively.
Analysis of incremental cost-effectiveness ratios suggested that the overdentures retained by one or two implants, were more cost-effective than the fixed implant treatment, considering the mean cost and effectiveness values and the ±20% one-way sensitivity analysis. **Conclusion:** This study suggests that the incremental costs for the fixed hybrid prosthesis, compared to the overdenture treatments, is not proportional to the respective gain in effectiveness. Therefore, although all treatment options had satisfactory outcomes, the use of implants to retain a mandibular overdenture, irrespective of the use of one or two implants, is more cost-effective than the fixed implant treatment for the edentulous mandible.

**INTRODUCTION**

The search for less complex and less costly treatments is an important issue in implant dentistry, since the incremental cost of implant treatments compared to conventional treatments remains a recognized barrier to the delivery of implant-supported dental prostheses [1]. Especially for geriatric patients, fear of surgery and pain, old age and high costs negatively influence their attitudes towards implant treatment [1-3]. Hence, strategies to improve patient access to the benefits of dental implants may include appropriate shared decisions between patients and professionals regarding the most suitable treatment option for the individual patient considering the invasiveness of treatment, potential risk of complications, and costs.

For the fully edentulous patient consensus statements [4-5] recommend treatment with a maxillary conventional denture and a 2-implant mandibular overdenture in order to stabilize the mandibular denture with implants, and also keep the initial cost of treatment low. In the long term, the differences regarding the entire cost over the expected life span of the patient may also be relatively small. Nevertheless, although previous studies provided sound evidence that mandibular implant-retained overdentures may be more satisfying for edentulous patients than new conventional dentures [6], the magnitude of such effect is still
uncertain, and there is a need for additional evidence including cost-effectiveness analyses on the impact of mandibular implant overdentures and conventional dentures [7].

Decisions regarding the choice of treatment is often influenced by economic criteria, related to both the costs of each alternative and the patient's financial condition, and it is surprising that there are still few studies focusing on the economic evaluation of implant treatment modalities for edentulous subjects. The relevance of developing studies linked to economic health assessment is to provide scientific evidence for the appropriate allocation of resources [8]. Therefore, providing the best care for the individual patient may also take into account the delivery of treatments with the better benefits along with the more efficient use of financial resources.

Thus, considering the principles of treatment simplification and the scarcity of studies addressing effectiveness and economic aspects of implant treatments, this study aims to evaluate the costs and outcomes of competing alternatives for the rehabilitation of the edentulous mandible using dental implants. This study reports a cost-effectiveness analysis performed as part of a randomized clinical trial comparing three treatment options: mandibular overdenture retained by a single implant, mandibular overdenture retained by two implants, and mandibular fixed prosthesis retained by four implants.

MATERIALS AND METHODS

Study design, sample and interventions

This is a cost-effectiveness analysis as part of a three parallel-group randomized clinical trial. The detailed description of the study methods, including sampling, patient allocation to the study groups, surgical and prosthodontics treatment procedures, and assessment of outcomes is available elsewhere [9]. This study was previously approved by the local research ethical committee (CAAE: 54455916.2.0000.5083) and registered at ClinicalTrials.gov database (NCT03056976). This report was based on the checklist of the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) [10].
The target population for this study was edentulous subjects who required provision of a new set of conventional complete dentures. All treatment procedures were performed in the research clinic of the School of Dentistry of the Federal University of Goiás, in Goiânia, central Brazil.

First, all participants received a set of conventional complete dentures. The steps for denture fabrication were as follows: (1) preliminary impression with stock trays and irreversible hydrocolloid; (2) fabrication of custom trays made of autopolymerizing acrylic resin; (3) final impression with zinc-oxide eugenol paste; (4) fabrication of base-plates and occlusal rims; (5) interocclusal records and articulator mounting; (6) teeth arrangement; (7) try-in visit; (8) laboratory processing with heat-cured acrylic resin; (9) denture delivery and post-insertion visits for adjustments.

After the adaptation period, were offered the opportunity to receive dental implants as part of the treatment and inclusion in the study. Patients were randomly assigned to one of the three study groups: (1) single midline implant to retain a mandibular overdenture – Group I; (2) two implants in the interforaminal region to retain a mandibular overdenture in the canine area bilaterally – Group II; and (3) four implants in the interforaminal region for an implant-supported fixed complete denture (IFCD) – Group III.

Implants (Titamax TI Cortical, Neodent, Brazil) were inserted using a single-stage surgical approach with conventional loading after a 3-month healing period. In summary, the surgical procedures included: (1) digital panoramic radiograph and lateral cephalometric radiograph for Group I, and digital panoramic radiograph and cone beam computed tomography of the anterior region of the mandible for groups II and III; (2) preoperative 2g amoxicillin, and 4mg dexamethasone for cases with more extensive surgery; (3) 0.1% chlorhexidine mouthwash; (4) local infiltration anesthesia with 4% articaine hydrochloride containing epinephrine 1:100,000; (5) crestal incision using a 15C disposable scalpel blade and mucoperiosteal flap; (6) osteotomy; (7) implant insertion; (8) healing abutment and suture; (8) denture relief and relining with temporary soft liner.
After the implant healing stage, the mandibular denture was attached to the implants, using specific retention systems and procedures according to the treatment group. For the overdenture groups, a nitrite-coated titanium ball attachment and a nylon matrix – O’ring attachment (Neodent, Brazil) was used for overdenture retention. For Groups I and II the existing mandibular denture was rebased and used for incorporation of attachments. For the IFCD group a new silicone impression was taken and a hybrid prosthesis fabricated with a Co-Cr framework and acrylic resin base with artificial denture teeth was attached to mini-conical abutments with a 32 Ncm torque (Neodent, Brazil).

**Effectiveness**

Treatment effectiveness was measured based on patient-reported outcome measures before and after implant-assisted prosthetic treatments. Patient satisfaction with the mandibular prostheses was the primary outcome measure. This was measured by a single question measured on a 10-cm uninterrupted Visual Analogue Scale which captured participants’ ratings of their general satisfaction with the mandibular prostheses. The patient was asked to indicate his/her level of satisfaction by marking a point along the scale, in which one extreme means “completely unsatisfied” and the other end means “completely satisfied”. Then the rating was converted into a value between 0 and 100 score along the scale.

Patient satisfaction was assessed after the provision of the new dentures (baseline) and at the 1-, 6- and 12-month follow-ups after implant provision. For the purpose of calculation of overall treatment effectiveness, the incremental changes in patient satisfaction was obtained by the difference between the 12-month and the baseline measurements.

**Cost-effectiveness analysis**

The cost-effectiveness analysis was planned from the perspective of the health provider, simulating a clinical treatment in a private clinical setting. We included only direct cost items comprising all relevant expenditures and human resources that could be attributed to the delivery of the specific treatments. Cost items were prospectively identified and quantified alongside all clinical and laboratory phases.
of patient care, from baseline assessment after complete denture treatment up to the 12-month follow-up, using a “bottom-up” costing estimation method. We used the Brazilian currency (BRL$) for cost estimation with no discounting rate. Costs related to the implementation of the prosthodontic and surgical care, such as acquisition and depreciation of equipment and items of lasting value, professional training, transportation fares, and administrative expenses were not included in the cost estimation. The methods for cost estimation are detailed in Table 1.

The quantification and valuing of human resources (dentist and auxiliary personnel) were performed by recording individually the clinical time of each appointment during the whole treatment period for all groups. Clinical time was registered in minutes and converted in “overall working hours for treatment”. Costs of labour force were valued considering the cost of working hours of the dentist and the dental assistant was calculated based on the minimum wage stipulated by the 2018 indexes of the National Federation of Dental Practitioners (FNO) – R$ 5,622.00 for the 8-hour daily work routine [11]. We also added a 40% bonus for unhealthy work and 23% for the specialization degree of the dentist. For the dental assistant the base salary was R$ 1,258.21, and the same criteria was applied, except for the additional bonus for specialization degree. Then, the total salary per month was converted into working time (in hours) for the manpower cost estimation.

The incremental cost-effectiveness ratio (ICER) was calculated as the overall parameter for the cost-effectiveness analysis: $ICER = \frac{(Cost_A - Cost_B)}{(Effect_A - Effect_B)}$, where “cost” was set as the overall treatment cost described in monetary units and “effect” the outcome measures in terms of patient-reported outcomes for the study groups. ICER compares two treatment modalities to determine which of them provides a more cost-effective relationship and also provides to decision-makers information on which alternative would offer more potential benefit, and where resources should be allocated when they are limited.

For calculation of the incremental cost and effectiveness, Groups I and III were assigned as treatment “A” (the new technology) and Group II (2-implant overdenture) was assigned as treatment “B” (the usual technology). The effectiveness of each treatment was calculated by the difference between the
overall outcome measured at the 12-month follow-up and at the baseline assessment (difference in effectiveness throughout the 1-year period due to the treatment provided). ICER was calculated considering the outcome patient satisfaction with the mandibular denture and was interpreted as a common effect that measures the difference in magnitude between the two alternatives using data retrieved from a clinical trial, expressed in terms of the incremental cost per unit of effect.

Further, a sensitivity analysis was conducted, since the estimated costs and outcome measures may vary across different clinical settings and considering that the use of different techniques may occur in a real-world condition, a sensitivity analysis was conducted to evaluate the impact of changes in various key parameters on the cost-effectiveness results. A non-probabilistic one-way sensitivity analysis was performed by inputting values to the outcome measures within the lower and upper limits of a 20% change of both the mean values of satisfaction scores (effectiveness) and costs.

Two hypothetical scenarios were generated by combining these 20% limits to simulate extreme conditions for the ICER estimation: (1) a best scenario that combines the worst possible outcome for Group I group and the best possible outcome for Groups II or III – that represent the higher incremental effectiveness and the lowest ICER value for a fixed treatment cost, and (2) a worst scenario that combines the best possible outcome for Group I and the worst possible outcome for Groups II or III – that represent the lower incremental effectiveness and the highest possible ICER value for a fixed treatment cost.

For data analysis, the IBM-SPSS 24.0 software was used for group comparisons, and the Microsoft Office Excel was used to construct the spreadsheets for cost estimations and ICER calculations.

RESULTS

Thirty-seven participants were submitted to implant surgery, had the prosthodontic treatment completed and were assessed until the 1-year follow-up (Group I = 11; Group II = 13; and Group III = 13).
**Effectiveness**

Satisfaction with the mandibular denture improved significantly from baseline to the 1-year follow-up (p<0.05) for the three treatment groups. Mean values changed from 67.2 (±33.9) to 85.6 (±27.6) in Group I, from 63.1 (±35.4) to 90.9 (±15.7) in Group II, and from 77.3 (±19.8) to 98.7 (±3.2) in Group III.

**Treatment costs**

The costs of treatments were estimated throughout the entire study. The construction of a detailed spreadsheet included all consumable items, implants, and prosthetic components, and laboratory services. Valuing labour workforce was initially based on the clinical time needed for performing all clinical procedures during complete denture treatment, implant treatment (surgical and prosthodontics) and post-insertion care. Table 2 shows the summary of clinical time (in minutes) according to the study groups and treatment phase. Significantly higher clinical time was found for Group III for the implant phase of the treatment (p<0.001). Regarding the overall treatment clinical time, significant differences (p=0.009) were found for the three groups (Group III > II > I).

Table 3 shows the detailed cost estimates for the study groups. The overall costs were R$ 2,370.66 for Group I, R$ 3,185.21 for Group II and R$5,739.52 for Group III (p<0.001). The implant phase included both the surgical procedures and the prosthodontic-related procedures (incorporation of attachments to the existing dentures for groups I and II, and fabrication of a new hybrid prosthesis for group III). Hence, the incremental costs refer to all treatment costs except those included in the conventional complete denture treatment. Percent incremental costs were estimated for each of the two competing treatment groups, by calculating the difference between the overall cost of each pair of groups and the proportion of this difference compared to the reference group cost, as follows: 
\[ \% \text{ Incremental Cost} = \left( \frac{\text{Cost}_A - \text{Cost}_B}{\text{Cost}_B} \right) \times 100 \]

Hence, Table 3 also shows that the percent incremental cost in relation to the complete denture phase range from 252% for Group I to 741% in Group III. Group III also had an overall incremental cost of 142% compared to Group I, and 80.2% compared to Group II (Table 3).
Figure 1 shows the absolute cost of each treatment phase (CD and implant phases) for the three treatment groups. The inclusion of the implant intervention implies a 2.5-fold increase in the overall cost of treatment in addition to the complete denture phase in Group I, and of 4.0 and 7.4 for Groups II and III, respectively. Figure 2 depicts the estimated costs of all items of the complete denture and implants phases of treatment according to the study groups. Findings show that the greater impact on treatment costs was the cost of implants and prosthetic components, as well as the laboratory cost for Group III.

Cost-effectiveness analysis

The cost-effectiveness analysis was based on the calculation of the incremental cost-effectiveness ratio (ICER) as the cost-outcome measure for comparison between treatments. We used patient satisfaction with the mandibular denture as the primary outcome (effectiveness measure) and overall direct cost for each treatment group.

Table 4 shows the summary data on outcome the measures, the costs for each treatment phase, incremental costs from CD to implant treatment, as well as overall costs per group. These data were used to calculate ICER values for the following pairwise comparisons:

- Before-and-after within-group comparison for the initial complete denture treatment and each of the final implant treatment groups;
- Between-group comparison for each two competing implant treatments using Group I as the reference strategy and Groups II and III as the tested strategies;
- Worst and best scenarios by the combined ± 20% change of costs and effectiveness for calculation of extreme ICER values.

Results suggest that the incremental costs for Group II compared to group I are considerably lower than Group III and, as the gain in effectiveness ranges from low to moderate in Groups II and III, respectively, compared to Group I, it may be concluded that the incremental costs for Group III is not proportional to the respective gain in effectiveness. Whilst the ICER for Group II (compared to Group
I) ranged from R$ 57.77 to R$ 129.98 for an incremental 1-point in patient satisfaction (base value = R$ 86.65), the same parameter for Group III (compared to Group I) ranged from R$ 748.64 to R$ 1,684.43 (base value = R$ 1122.95). Therefore, results suggest that the use of implants to retain a mandibular overdenture, irrespective of the use of one or two implants, are more cost-effective than the fixed implant treatment for the edentulous mandible.

**Sensitivity analysis**

The graph of sensitivity analysis in Figure 3 details the full range of variation in ICER values for the three treatment groups compared to the complete denture treatment. ICER values are represented by the base case values from the clinical trial data and the hypothetical ± 20% limits for changes in the cost and effectiveness parameters. The line for ICER values of Group III was reversed for comparison against the overdenture groups concerning the full range between the most and less favourable hypothetical scenarios. Results show that Group III had higher costs for 1 unit of effectiveness compared to the overdentures (Groups I and II), which means that was less cost-effective. However, the 1- or 2-implant overdenture could be less advantageous in case of the lowest ICER values for Group III (best scenario) and highest ICER for Groups I and II (worst scenario).

**DISCUSSION**

The overall aim of this study was to perform a cost-effectiveness analysis as part of a randomized clinical trial comparing three different implant treatment alternatives for the edentulous mandible in complete edentulous subjects. The results of this study, therefore, are of high clinical relevance and may contribute to the decision-making process when choosing between different alternatives for the rehabilitation of the edentulous mandible. The results of this experimental study may provide evidence about the effectiveness of simplified and low-cost interventions for edentulous subjects, especially for older people, who may be affected by the functional and psychological implications related to the use of unstable and uncomfortable mandibular dentures, and are less likely to adhere to complex and invasive implant interventions.
Considering that most patients live well with their conventional dentures, and even having minor to moderate complaints they stay using the dentures for years, the decision to change for new dentures or receive implants to improve denture functioning is based on individual predisposing factors, perceived needs, and financial capacity [12]. In this study, patients did not incur any treatment costs and decisions were based on voluntary inclusion and random allocation to treatment groups. This differs from a real clinical setting, where acceptance of treatment options are limited by factors including costs and patient preference.

A previous report on economic aspects of implant-supported prosthesis in the Brazilian scenario suggested that the two-implant overdenture has a low incremental cost and was more effective than the conventional complete dentures [13]. Similarly, our study demonstrated that there were small incremental costs for Group II compared to group I, and a high incremental cost from the overdenture groups (Groups I and II) compared to the hybrid 4-implant prosthesis (Group III). However, the gain in effectiveness from the conventional dentures to the implant treatments was similar for the three groups. It would appear that the incremental costs for Group III was not proportional to the respective gain in effectiveness and, therefore, results suggest that the use of implants to retain a mandibular overdenture, irrespective of the use of one or two implants, are more cost-effective than the fixed implant treatment for the edentulous mandible. A previous randomized clinical trial by Walton et al. [14] comparing the cost and outcomes between mandibular overdentures retained by one or two implants also showed that the use of a single implant resulted in lower component costs and treatment times, with comparable satisfaction and maintenance time after one year, suggesting that it may be an alternative to the two-implant overdenture.

Findings from this clinical trial regarding patient satisfaction and quality of life impacts [9] showed similar improvements on the transition from the complete denture phase to the implant-retained prosthesis, although the implant-supported fixed prosthesis perform slightly better than the removable prostheses concerning the overall magnitude of treatment effect size [9]. A systematic review by Kern et al. [15] also reported higher post-loading implant survival and success for the fixed implant treatment. Nevertheless, differences in implant survival rates are of
lower relevance when considering other primary outcomes such as improvement on masticatory performance, hygiene capability, psychological aspects, and financial considerations [15].

From the economic perspective, a systematic review of clinical studies [16] reported that implant overdentures were more cost-effective than implant-supported fixed complete dentures. A number of studies investigated the cost-effectiveness of different implant-supported overdentures [17-23]. Another systematic review of these studies by Vogel et al., [24] concluded that although implant-retained overdentures may be associated with high initial treatment costs, they are more likely to represent a cost-effectiveness option in comparison to complete dentures. However, implant-related alternatives (removable or fixed) comprise a wide range of interventions, from extremely simple to extremely complex and costly interventions, that include advanced technologies and procedures that may rise the impact of treatment costs on the decisions about the individual patient care.

In addition, there are several aspects may be considered in an economic assessment of health interventions, especially in case of a competing treatment that is expected to cost more and be more effective than alternative interventions [25]. Even when patients can pay for treatment costs, there are unrecoverable costs that are the opportunity costs, which are costs of a potential benefit foregone [26]. Cost opportunity is relevant because people have different values about costs. This means that in a situation in which a choice needs to be made between several mutually exclusive alternatives given the patients’ limited resources, they make different judgments about value for money, and they have to decide whether a health procedure is worth doing compared with other things they could do with the same resources (i.e., spending on X takes away the opportunity to spend on Y). In summary, the real cost of an intervention is not measured solely by the monetary budgets, but rather the value of the benefits achievable in one intervention that was chosen (for example, an implant-supported prosthesis) compared to another alternative that was foregone (for example, buying a new car).
Another limitation of this study is the limited time horizon for assessment of treatment costs and outcomes. For example, although the fixed implant denture group was associated with higher immediate costs compared to the overdenture groups, long-term costs tend to accrue rather uniformly over time. Therefore, overdenture treatments with lower short-term costs may not be as attractive relative to other more complex options when a long-term follow-up is considered. Further studies with longer follow-up periods are needed to provide a more comprehensive depiction of the cost burden to patients and care providers [18].

Hence, the main economic challenge is to provide the best possible allocation of resources along with the provision of the most effective and beneficial technologies, minimizing the waste of resources, inefficiency, and inequalities in access to health care [27]. However, the lack of sound evidence on the cost and consequences of implant interventions makes it difficult to identify clearly the most cost-effective course of action without a systematic analysis of all relevant costs (direct and indirect) and the consequences of treatments. To better assess the efficiency of implant-supported prostheses in various clinical conditions, more economic evaluations are needed that follow well-established methodologies in health economics. Evidence on the efficiency of an implant-supported prosthesis in various clinical conditions and settings demand further economic evaluations, using reproducible methods and reporting results following standard guidelines for health economic evaluation such as the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement [10] for more reliable comparison across studies.

Moreover, we opted to report cost data in the original currency (BRL$). Due to the significant variations in the exchange rates, we did this to overcome uncertainty over currency conversion factors and its problems when translating and interpreting economic evaluations from distinct countries, which makes the use of foreign evaluations in healthcare decision-making unreliable [28]. Although the purchasing power parities (PPPs) are commonly used to convert the costs of goods and services which are priced in different currencies to avoid the methodological problems of exchange rates, we considered that in this clinical decision scenario it is quite difficult to obtain reliable cost estimates across
different clinical settings, and different countries. Moreover, the focus of this study was to compare the relative costs of different treatment approaches, considering both the overall costs and the partial costs in each of the treatment phases. Therefore, proper conclusions can be drawn, irrespective of the currency exchange rates.

Finally, it is important to consider that the findings of this study does not mean that one treatment is recommended over another, since the results of an economic analysis aim to provide information for patients, health providers, and stakeholders, about the relations between costs and probable outcomes. The potential use of economic analysis in healthcare decision making has strong natural appeal as it becomes clear how an individual's healthcare decisions can affect the ability of others to obtain the care they need [29].

**CONCLUSIONS**

Within the limits of this cost-effectiveness analysis, we found that the incremental costs for the 2-implant overdenture (Group II) compared to the single-implant overdenture (Group I) are considerably lower than the 4-implant fixed prosthesis (Group III) and, as the gain in effectiveness ranges from low to moderate in Groups II and III, respectively, compared to Group I, it may be concluded that the incremental costs for Group III is not proportional to the respective gain in effectiveness.

This economic analysis suggests that the use of implants to retain a mandibular overdenture, irrespective of the use of one or two implants, is more cost-effective than the fixed implant treatment for the edentulous mandible.

**AKNOWLEDGEMENTS**

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REFERENCES


FIGURE LEGENDS

Figure 1. Costs of complete denture and implant treatment phases.

Figure 2. Estimated costs of items for the complete denture and implants phases of treatment according to the study groups.

Figure 3. Sensitivity analysis: ± 20% variation in ICER values by changing the cost and effectiveness parameters. The line for ICER values of the IFCD (Group III) is reversed for comparison with the overdenture groups (I and II).
Table 1. Description of cost items and methods for quantification, cost estimation methods and sources of valuing the direct cost items.

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantification of costs</th>
<th>Estimation method</th>
<th>Source of valuing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manpower</td>
<td>(Month salary / monthly working time) x clinical time for treatment</td>
<td>Microcosting (Time in minutes)</td>
<td>Reference salary</td>
</tr>
<tr>
<td>Consumables</td>
<td>Total cost items / number of patients</td>
<td>Microcosting</td>
<td>Mean market prices</td>
</tr>
<tr>
<td>Prosthetic laboratory</td>
<td>Prices per unit</td>
<td>Gross costing</td>
<td>Mean market prices</td>
</tr>
<tr>
<td>Imaging exams</td>
<td>Prices per unit</td>
<td>Gross costing</td>
<td>Mean market prices</td>
</tr>
<tr>
<td>Implants and prosthetic components</td>
<td>Prices per unit</td>
<td>Microcosting</td>
<td>Catalogue prices</td>
</tr>
</tbody>
</table>
Table 2. Clinical time for treatment (in minutes) for the complete denture, implant and post-insertion phases, according to the study groups. Data are expressed as means and standard deviations.

<table>
<thead>
<tr>
<th>Treatment phase</th>
<th>Group I (n=10)</th>
<th>Group II (n=12)</th>
<th>Group III (n=12)</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete denture</td>
<td>174.7 (29.5)&lt;sup&gt;A&lt;/sup&gt;</td>
<td>181.7 (46.5)&lt;sup&gt;A&lt;/sup&gt;</td>
<td>177.4 (57.2)&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.933</td>
</tr>
<tr>
<td>Implant</td>
<td>162.1 (57.2)&lt;sup&gt;A&lt;/sup&gt;</td>
<td>204.3 (71.3)&lt;sup&gt;A&lt;/sup&gt;</td>
<td>327.7 (109.3)&lt;sup&gt;B&lt;/sup&gt;</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Post-insertion</td>
<td>31.8 (43.9)&lt;sup&gt;A&lt;/sup&gt;</td>
<td>41.3 (68.5)&lt;sup&gt;A&lt;/sup&gt;</td>
<td>40.8 (42.2)&lt;sup&gt;A&lt;/sup&gt;</td>
<td>0.908</td>
</tr>
<tr>
<td>Total</td>
<td>368.6 (92.0)&lt;sup&gt;A&lt;/sup&gt;</td>
<td>427.3 (127.7)&lt;sup&gt;AB&lt;/sup&gt;</td>
<td>545.9 (153.7)&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.009</td>
</tr>
</tbody>
</table>

* One-way Anova followed by Tukey's test. Different letters mean significant difference in pairwise multiple comparisons
Table 3. Cost estimates for the treatment groups, according to the treatment phases and cost items (data are mean costs).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cost items</th>
<th>Group I</th>
<th>Group II</th>
<th>Group III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct costs: CD phase</td>
<td>Consumables</td>
<td>R$ 207.54</td>
<td>R$ 201.90</td>
<td>R$ 213.80</td>
</tr>
<tr>
<td></td>
<td>Laboratory</td>
<td>R$ 393.00</td>
<td>R$ 385.90</td>
<td>R$ 380.08</td>
</tr>
<tr>
<td></td>
<td>Manpower</td>
<td>R$ 73.16</td>
<td>R$ 55.44</td>
<td>R$ 88.44</td>
</tr>
<tr>
<td>Direct costs: Implant phase</td>
<td>Consumables</td>
<td>R$ 162.85</td>
<td>R$ 128.09</td>
<td>R$ 409.03</td>
</tr>
<tr>
<td></td>
<td>Laboratory</td>
<td>R$ 10.91</td>
<td>R$ 0.00</td>
<td>R$ 951.54</td>
</tr>
<tr>
<td></td>
<td>Implant and prosthetic components</td>
<td>R$ 697.00</td>
<td>R$ 1,368.71</td>
<td>R$ 2,324.69</td>
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<td></td>
<td>Exams</td>
<td>R$ 62.20</td>
<td>R$ 223.00</td>
<td>R$ 223.00</td>
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<tr>
<td></td>
<td>Manpower</td>
<td>R$ 764.01</td>
<td>R$ 822.17</td>
<td>R$ 1,148.94</td>
</tr>
<tr>
<td>Sub-total (per phase)</td>
<td>Complete denture phase</td>
<td>R$ 673.70</td>
<td>R$ 643.24</td>
<td>R$ 682.32</td>
</tr>
<tr>
<td></td>
<td>Implant phase</td>
<td>R$ 1,696.96</td>
<td>R$ 2,541.97</td>
<td>R$ 5,057.20</td>
</tr>
<tr>
<td>Total cost</td>
<td>All items</td>
<td>R$ 2,370.66</td>
<td>R$ 3,185.21</td>
<td>R$ 5,739.52</td>
</tr>
<tr>
<td>Incremental cost - (%)</td>
<td>Reference: CD treatment</td>
<td>252 %</td>
<td>395%</td>
<td>741%</td>
</tr>
<tr>
<td></td>
<td>Reference: Group I</td>
<td>-</td>
<td>34.4%</td>
<td>142.1%</td>
</tr>
<tr>
<td></td>
<td>Reference: Group II</td>
<td>-25.6%</td>
<td>-</td>
<td>80.2%</td>
</tr>
<tr>
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<td>Reference: Group III</td>
<td>-58.7%</td>
<td>-44.5%</td>
<td>-</td>
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</tbody>
</table>
Table 4. Cost-effectiveness analysis.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Baseline outcome measure</th>
<th>12-month outcome measure</th>
<th>Incremental effectiveness</th>
<th>Cost CD phase</th>
<th>Cost Implant phase</th>
<th>Incremental cost (Implant – CD)</th>
<th>Total cost</th>
<th>ICER Ref. = CD</th>
<th>ICER Ref. = Group I</th>
<th>Worst scenario*</th>
<th>Best scenario*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>67.2</td>
<td>85.6</td>
<td>18.4</td>
<td>R$ 673.7</td>
<td>R$ 1,697.0</td>
<td>R$ 1,023.3</td>
<td>R$ 2,370.7</td>
<td>R$ 55.61</td>
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<td></td>
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<tr>
<td>Group II</td>
<td>63.1</td>
<td>90.9</td>
<td>27.8</td>
<td>R$ 643.2</td>
<td>R$ 2,542.0</td>
<td>R$ 1,898.7</td>
<td>R$ 3,185.2</td>
<td>R$ 68.30</td>
<td>R$ 86.65</td>
<td>R$ 129.98</td>
<td>R$ 57.77</td>
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<tr>
<td>Group III</td>
<td>77.3</td>
<td>98.7</td>
<td>21.4</td>
<td>R$ 682.3</td>
<td>R$ 5,057.2</td>
<td>R$ 4,374.9</td>
<td>R$ 5,739.5</td>
<td>R$ 204.43</td>
<td>R$ 1,122.95</td>
<td>R$ 1,684.43</td>
<td>R$ 748.64</td>
</tr>
</tbody>
</table>

CD – Complete denture
ICER – Incremental Cost-Effectiveness Ratio
* Worst and best scenario based on a 20% combined increase/decrease in cost and effectiveness