# A Cost Comparison of Mandibular Two-Implant Overdenture and Conventional Denture Treatment

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***Purpose:*** This article compares the cost of mandibular two-implant overdenture treatment to that of conventional denture treatment in an academic teaching hospital. ***Materials and Methods:*** Sixty edentulous patients (aged 65 to 75 years) participated in a randomized clinical trial. All patients received a new maxillary complete denture and either a mandibular conventional denture (n = 30) or an implant overdenture on two unsplinted implants (n = 30). Resource-based microcosting of direct and indirect costs (eg, expenses and time cost to patients) of all scheduled and unscheduled visits was conducted through 1 year following delivery of the prostheses. ***Results:*** Mean direct costs (1999 CD$) for scheduled visits in the implant and conventional groups were $2,332 and $814, respectively, and mean indirect costs were $1,150 and $810, respectively. Differences between the two groups were significant. Twenty-six patients in each group had unscheduled visits during the study at a median direct cost for the overdentures of $85 and $64 for the conventional dentures. Median indirect costs for unscheduled visits were $163 and $202, respectively. These differences were not significant. Mean total costs of the overdentures were $4,245 and $2,316 for the conventional dentures, and the between-group difference was significant. ***Conclusion:*** The direct cost of mandibular two-implant overdenture treatment was 2.4 times higher than that of conventional denture treatment. When indirect costs were added, the implant-to-conventional total cost ratio estimate was 1.8. These cost data can now be combined with estimates of the efficacy of the two types of prosthesis so practitioners and patients can make informed decisions about these prosthodontic treatment concepts. *Int J Prosthodont 2004;17:181–186.*

Several studies have shown that implant-supported prostheses for the restoration of edentulous jaws are safe and beneficial.[1,2] However, the high initial charge for multiple implant prostheses forces most patients, especially the elderly, to accept less-expensive options, usually treatment with conventional dentures. Previous research has shown that edentulous patients tend to come from lower income brackets.[3] To help them, it is crucial to study the simplest implant treatment modalities that could replace conventional dentures in the general population. Estimates of efficacy and costs are important information for patients, health providers, and third-party payers.

There has been phenomenal growth in the economic evaluation of health care programs in the last two decades. However, the literature covering dental care programs has been increasing more slowly.[4,5] According to current guidelines,[6] an economic evaluation should include the cost of resources employed in the provision of health care, as well as the cost of the time

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spent by patients during treatment. Other than that of Attard et al,[7] no comprehensive cost analysis of implant treatments including time cost to patients has yet been carried out.[8–10]

Because of their simplicity, mandibular unsplinted two-implant overdentures (IOD) have the potential to be less expensive than other implant prostheses. Although the frequency of long-term postinsertion prosthodontic maintenance has not been shown definitively,[11,12] the authors found no significant differences in the time taken by prosthodontists to fabricate and maintain this implant prosthesis and a conventional prosthesis.[13]

The aim of this article is to compare the cost of mandibular IOD treatment with the cost of conventional denture (CD) treatment through 1 year after delivery of the prostheses. This analysis was conducted as part of a randomized controlled trial (RCT) involving elderly edentulous patients in Montreal, Canada. Resource-based microcosting of the direct and indirect costs of all scheduled and unscheduled visits through 1 year after delivery of the prostheses was conducted. The hypothesis was that the costs through 1 year after delivery would be greater for mandibular IOD treatment than for CD treatment.

## Materials and Methods

### *Study Design*

Sixty edentulous participants (aged 65 to 75 years) who met all inclusion and exclusion criteria[13] gave informed consent and participated in the study. The determination of the sample size was based on the primary outcome,[14] general satisfaction with treatment. Patients were randomly assigned to the IOD group (n = 30) or the CD group (n = 30). Two root-form implants (ITI, Straumann) were surgically placed between the mental foramina in all IOD patients, followed by retentive anchors and then gold matrices in the overdenture, as described elsewhere.[13]

Visits were classified into scheduled and unscheduled (solicited by patients).[13] All visits were placed in the following categories: from preliminary examination to final postoperative reline (SP), preliminary impressions to delivery (P1), delivery to 2 months later (P2), 2 to 6 months after delivery (P3), and 6 months to 1 year after delivery (P4).

### *Cost Calculation*

Costs were classified as direct and indirect. Direct costs include the cost of labor, materials, medications, laboratory fees, and radiography fees. Indirect costs include the patients' time costs and out-of-pocket expenses. All costs were measured in 1999 Canadian dollars.

To determine the opportunity costs of labor, the time spent by the clinicians and surgical assistants was measured by a member of the research team using a stopwatch. This time included set up, treatment, clean up, and administrative tasks associated with patient contacts. A detailed account of the time spent at each treatment stage has been reported previously.[13,15] The opportunity costs of time were estimated from data on Quebec incomes and hours worked from the 1996 Canadian Census.[16] After adjusting for inflation, the mean hourly wages of dentists and dental assistants in 1999 were estimated to be $51.97 and $15.87, respectively. Since 91% of all Quebec dentists were general practitioners in 2001 (personal communication, Canadian Dental Association), the census data on dentist wages provide a reasonable estimate of general practitioner income. Since there are no data available on the incomes of Canadian oral surgeons, auxiliary data from the ratio of specialist to generalist incomes in the US[17] were used to develop estimates of the incomes of Quebec oral surgeons. Since the American Dental Association (ADA) data[18] showed that the oral surgeon–general practitioner wage ratio was 1.44, this ratio was applied to the data from the Canadian census to obtain an estimate of the value of an oral surgeon's time at $73 per hour. The wage of the prosthodontist was estimated at $52. Fringe benefit costs for clinicians and staff were included in the overhead cost calculations described below.

All disposable and reusable materials used were recorded. A product catalogue (Henry Schein) was used to acquire their market prices. Twenty-eight local dentists, both general practitioners and specialists, filled out a questionnaire in which they estimated the useful life and the frequency of use per week of the reusable items. These data were not normally distributed, so the median values for estimated useful life of reusable items were calculated. Using these values, together with the purchase price of each item and a discount rate of 5% for each item, the equivalent annualized cost was computed.[19] The cost per use was then estimated by dividing the equivalent annual cost by the estimated frequency of use in 1 year.

Laboratory costs were based on the fee charged by a commercial dental laboratory to make and repair all of the prostheses that were manufactured. Drug prices were obtained from a retail pharmacy. The cost of each panoramic radiograph, including time spent on evaluation, was calculated by the Department of Quality Control for the Royal Victoria Hospital to be $27.23.[15]

Indirect costs included the time spent for travel by patients seeking treatment and the cost of transportation. The duration of each visit was also recorded. The human capital method was used to calculate the value of this time,[20] which was based on

**Table 1** Scheduled Visits: Direct Cost of Treatment (CD$; n = 30)*

| | Implant overdenture group (IOD) | | | | | Conventional denture group (CD) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Time point | Clinician costs, OS | Clinician costs, PRO | Material costs | Other costs† | Total costs | Clinician costs, OS | Clinician costs, PRO | Material costs | Other costs† | Total costs |
| Preliminary exam‡ | 7 | 6 | 1 | 27 | 42 | 0 | 6 | 1 | 0 | 7 |
| Preoperative informed consent | 20 (7) | 0 | 1 (1) | 0 | 22 (7) | 0 | 0 | 0 | 0 | 0 |
| Implant placement | 88 (15) | 0 | 791 (8) | 44 (8) | 923 (21) | 0 | 0 | 0 | 0 | 0 |
| Postoperative/ suture removal | 11 (11) | 0 | 2 (1) | 0 | 12 (12) | 0 | 0 | 0 | 0 | 0 |
| Postoperative/ denture reline | 0 | 26 (10) | 5 (2) | 0 | 31 (10) | 0 | 0 | 0 | 0 | 0 |
| Preliminary impressions | 0 | 13 (5) | 4 (1)¶ | 27 (NA) | 45 (6)¶ | 0 | 12 (3) | 3 (1)¶ | 0 | 16 (3)¶ |
| Final impressions | 0 | 49 (12)¶ | 260 (68)¶ | 0 | 309 (73)¶ | 0 | 41 (7)¶ | 26 (5)¶ | 0 | 66 (9)¶ |
| VDO/CR and tooth selection | 0 | 39 (8) | 6 (3)¶ | 0 | 45 (45) | 0 | 43 (12) | 3 (2)¶ | 0 | 46 (13) |
| Try-in | 0 | 20 (15) | 4 (5) | 0 | 24 (16) | 0 | 24 (17) | 3 (2) | 0 | 27 (18) |
| Delivery | 0 | 81 (28)¶ | 133 (63)¶ | 573 (14) | 784 (81)¶ | 0 | 65 (18)¶ | 6 (3)¶ | 533 (14) | 603 (25)¶ |
| 2-mo follow-up | 0 | 17 (10) | 4 (3) | 0 | 21 (13) | 0 | 15 (17) | 3 (2) | 0 | 19 (18) |
| 6-mo follow-up | 0 | 11 (5)¶ | 3 (3) | 0 | 14 (7)¶ | 0 | 8 (4)¶ | 3 (1) | 0 | 10 (5)¶ |
| 1-y follow-up | 0 | 23 (12)¶ | 8 (14) | 27 (NA) | 58 (20)¶ | 0 | 17 (8)¶ | 3 (1) | 0 | 20 (9)¶ |
| Total | 127 (22) | 284 (38)¶ | 1,223 (93)¶ | 698 (15) | 2,332 (112)¶ | 0 | 230 (47)¶ | 51 (7)¶ | 533 (14) | 814 (51)¶ |

*Data presented as mean (standard deviation).
†Sum of surgical assistant, laboratory, radiography, and drug costs.
‡Median from a subset of 42 patients for whom this cost was measured.
¶IOD > CD, $P < .050$ (Student's *t* test).
OS = oral surgeon; PRO = prosthodontist; VDO/CR = vertical dimension of occlusion in centric relation.

the 1999 average wage estimate for Quebec workers aged 55 years and older ($17.16 per hour).[21] Transportation expenses were estimated from a self-administered questionnaire. Mean transportation cost per visit and mean transportation time were $33.75 and 120 minutes, respectively. Hence, the mean patient costs associated with time losses and transportation were $69.79 per visit.

### *Overhead Cost*

No published data on practice expenses in Canada are available. Therefore, data from the ADA[22] that describe the various categories of practice expenses as a percentage of the gross billing of solo unincorporated specialists were used. Adjusting the ADA data to accommodate the particular features of the practices studied here, the practice overhead was calculated to be 40% and 38% of total billings for oral surgeons and prosthodontists, respectively. Since the ADA data show that gross billings are roughly twice the income for specialists, twice the estimated clinician expense was used as the base figure on which to calculate the overhead rate.

### *Statistical Analysis*

To compare the two groups, the Student's *t* test or Mann-Whitney *U* test was performed using SPSS (SPSS).

## Results

### *Scheduled Visits*

The mean total direct costs of scheduled visits were $2,332 for IODs and $814 for CDs, yielding an IOD/CD cost ratio of 2.9 (Table 1). The difference in direct costs was statistically significant ($P < .001$).

The mean total indirect costs in the IOD and CD groups were $1,150 and $810, respectively, and the difference was statistically significant ($P < .050$; Table 2).

### *Unscheduled Visits*

Twenty-six participants in each group required unscheduled treatment from SP to P4 (Table 3). Data were not normally distributed, so the median direct costs were used. These were higher in the IOD ($85) than the CD ($64) group, although the difference was not statistically significant ($P = .742$). For the period after delivery (P2 to P4), the median cost was lower for the IODs ($57) than the CDs ($75). Again, the difference was not significant ($P = .258$).

Median indirect costs from SP to P4 were $163 and $202 in the IOD and CD groups, respectively ($P = .687$; Table 4). However, during the period following delivery (P2 to P4), median cost was lower for the IODs ($146) than the CDs ($234), and the difference was significant ($P = .050$).

**Table 2** Scheduled Visits: Indirect Cost (CD$; n = 30)*

| Time point | Implant overdenture (IOD) group | Conventional denture (CD) group |
|---|---|---|
| Preliminary exam† | 72 | 72 |
| Preoperative informed consent | 81 (3) | 0 |
| Implant placement | 103 (5) | 0 |
| Postoperative/suture removal | 73 (50) | 0 |
| Postoperative/denture reline | 78 (2) | 0 |
| Preliminary impressions | 76 (2) | 75 (2) |
| Final impressions | 94 (25)‡ | 83 (2)‡ |
| VDO/CR and tooth selection | 84 (3) | 82 (3) |
| Try-in | 96 (41) | 121 (62) |
| Delivery | 164 (20)‡ | 154 (16)‡ |
| 2-mo follow-up | 76 (4) | 75 (6) |
| 6-mo follow-up | 76 (4) | 76 (14) |
| 1-y follow-up | 76 (4) | 74 (3) |
| Total | 1,150 (54)‡ | 810 (73)‡ |

*Data presented as mean (standard deviation).
†Median from a subset of 42 patients for whom this cost was measured.
‡IOD > CD, $P < .050$ (Student's *t* test).
VDO/CR = vertical dimension of occlusion in centric relation.

**Table 3** Unscheduled Visits: Direct Cost (CD$)*

| | Oral surgeon | | Prosthodontist | | Total | |
|---|---|---|---|---|---|---|
| Time point† | Costs | n | Costs | n | Costs | n |
| IOD group | | | | | | |
| SP | 21 (586) | 6 | 20 (61) | 12 | 22 (645) | 14 |
| P1 | 121 (780) | 4 | 21 (556) | 6 | 73 (849) | 7 |
| P2 | — | 0 | 27 (196) | 20 | 27 (196) | 20 |
| P3 | — | 0 | 92 (131) | 4 | 92 (131) | 4 |
| P4 | 28 (NA) | 1 | 82 (160) | 5 | 82 (160) | 5 |
| Total | 48 (825) | 8 | 85 (773) | 25 | 85 (1,085) | 26 |
| CD group | | | | | | |
| SP | — | 0 | 11 (NA) | 1 | 11 (NA) | 1 |
| P1 | — | 0 | 15 (NA) | 1 | 15 (NA) | 1 |
| P2 | — | 0 | 28 (160) | 24 | 28 (160) | 24 |
| P3 | 8 (NA) | 1 | 42 (229) | 7 | 42 (229) | 7 |
| P4 | 133 (138) | 3 | 91 (212) | 12 | 89 (913) | 13 |
| Total | 73 (143) | 4 | 64 (1,120) | 26 | 64 (1,120) | 26 |

*Data presented as conditional median (interquartile range).
†See Materials and Methods section for definition of time points.
n = No. of patients on whom median calculation was based; IOD = implant overdenture; CD = complete denture.

**Table 4** Unscheduled Visits: Indirect Cost (CD$)*

| | Implant overdenture group | | Conventional denture group | |
|---|---|---|---|---|
| Time point† | Cost | n | Cost | n |
| SP | 77 (317) | 14 | 74 (NA) | 1 |
| P1 | 143 (589) | 7 | 74 (NA) | 1 |
| P2 | 84 (228) | 20 | 124 (317) | 24 |
| P3 | 151 (97) | 4 | 144 (238) | 7 |
| P4 | 149 (161) | 5 | 163 (783) | 13 |
| Total | 163 (1,135) | 26 | 202 (1,324) | 26 |

*Data presented as conditional median (interquartile range).
†See Materials and Methods section for definition of time points.
n = No. of patients on whom median calculation was based.

### *Scheduled and Unscheduled Visits*

Total costs were $4,245 (IOD) and $2,316 (CD), and differences between the two groups were statistically significant for all measures of cost at all stages ($P < .001$). The IOD/CD cost ratio for direct costs was 2.4, and for total cost, it was 1.8 (Table 5).

**Table 5** Direct and Indirect Cost (CD$): Scheduled and Unscheduled Visits (n = 30)*

| Cost | Implant overdenture group | Conventional denture group |
|---|---|---|
| Direct | 2,490 (2,387–2,549)† | 962 (860–1,063)† |
| Direct (including overhead) | 2,850 (2,727–2,974)† | 1,193 (1,056–1,329)† |
| Indirect | 1,395 (1,301–1,489)† | 1,123 (968–1,278)† |
| Total | 3,885 (3,697–4,074)† | 2,085 (1,833–2,337)† |
| Total (including overhead) | 4,245 (4,037–4,454)† | 2,316 (2,028–2,603)† |

*Data presented as mean (95% confidence interval).
†$P < .050$ (Student's *t* test).

## Discussion

This study has described all of the costs of treating edentulous elderly individuals with maxillary CDs and mandibular CDs and IODs up to 1 year after delivery of the prosthesis. This comparison is important because the implant treatment evaluated here is simpler and potentially less costly than other types that have been previously evaluated.[1,2] In contrast to some published studies of conventional and implant prostheses,[7,10] our cost estimates were based on observed resource utilization and the opportunity costs of these resources, rather than on clinician charges. Health economists and various government bodies charged with health technology assessment have concluded that charge data are usually inappropriate in an economic analysis because they often deviate from true costs.[6,20,23] Furthermore, guidelines[20,24] for health technology assessment recommend a social perspective that includes burden on patients. This is the first study of conventional and implant overdentures that includes the time and transportation costs of treatment for patients.

We calculated the IOD/CD cost ratio for direct costs, including overhead, so that we could compare the relative costs of the implant treatment evaluated here with those reported in other studies. The total direct costs for the IOD ($2,850) were 2.4 times higher than those for the CD ($1,193) up to 1 year after prosthesis delivery. The main determinants of this difference were the cost of materials (implants, patrix and matrix components) and the time spent by the clinician during the surgical stage of implant treatment. Although it has been reported that the rate of complications with two-implant mandibular overdentures is higher than that of CDs,[11] we found no between-group differences in the cost of unscheduled visits up to 1 year after prosthesis delivery.

The indirect costs to patients were substantial; $1,395 and $1,123 for the IODs and CDs, respectively, through 1 year postdelivery. Although the difference was statistically significant, it was not great ($162) and was a result of the three additional visits required by the IOD group (17.5 vs 14.2).

A previous work estimates the cost of implant-fixed prostheses through 5 years after the surgical implant placement to be 6.5 times greater than that of conventional treatment.[8] The difference observed in the cost ratio calculated here is due, in part, to the fact that the implant-fixed prostheses evaluated in the previous study[8] required multiple implants and two-stage surgery, whereas only two implants, placed during a single visit, were used in our study. An earlier study carried out in Canada calculated the costs of providing overdentures on splinted and unsplinted Brånemark implants[10] (Nobel Biocare). However, that study focused on the fabrication period only (P1) and was based on charges of clinicians in British Columbia rather than on microcosting of the time and materials required for fabrication. The authors reported that the mean cost for fabrication of an overdenture on unsplinted implants was $2,363, excluding the surgical procedures; the estimated cost for the corresponding treatment period in our study was $1,428. Since the time and material resources used by British Columbian clinicians were not reported, it is not possible to determine whether the differences are due to differences in resources used, in interprovincial costs of these resources, or in the wages of clinicians and staff.

Another published study[9] has compared the cost of mandibular two-implant overdentures with a splinted design to CD treatment using the microcosting method, but excluding indirect costs. Their estimation of time spent by the clinicians during the prosthodontic phase was similar to ours, but they reported that it cost 3.08 times more to provide a two-implant mandibular overdenture on the splinted implants than a CD in the first year.[9] The higher direct cost ratio in their study appears to be due to the cost of the bar attachment, plus the fact that the implant system they used required two surgical visits. The simple, one-stage surgery treatment method evaluated here is less resource intensive. Furthermore, the inclusion of indirect costs in our analysis shows that the total cost ratio of two-implant overdentures on unsplinted implants to CDs is substantially lower than that shown by direct costs alone (1.8 vs 2.4).

A recent publication[7] described results of a chart survey of both direct and indirect costs for the provision of mandibular fixed and splinted two-implant overdentures. Those initial clinical and complication costs, based on economic estimates from 1995, reveal that the cost of the IOD treatment was CD$3,043. Our finding of CD$2,850 was lower, perhaps because the implants used in our study were unsplinted.

The description of all costs associated with treatment is an essential step in the development of an understanding of the cost effectiveness of this overdenture treatment concept. Combining these costs with the various measures of the efficacy of implant-supported and conventional prostheses will provide the cost-effectiveness estimates that practitioners and patients need to make informed decisions about these prosthodontic treatments. Interpretation of our findings should take into account that: *(1)* treatment was performed by one oral surgeon and one prosthodontist; *(2)* the study was conducted in an academic teaching hospital; and *(3)* long-term data on both effectiveness and costs are necessary for a complete economic evaluation.

## Acknowledgments

This study was supported by grant No. 36052 from the Canadian Institutes of Health Research and Straumann Canada Limited. We thank Dr Esa Klemetti for his clinical contributions, and Stephanie Wollin for her help with the manuscript.

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