Efficient Resource Use in Simplified Complete Denture Fabrication

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Abstract

Purpose: Conventional dentures will remain the only treatment available to most edentulous people for the foreseeable future. In this study, we compared the efficiency of two methods of making complete conventional dentures—the traditional academic standard (T) and a simplified technique (S) used in private practice. We have previously shown that they produce similar levels of patient satisfaction and denture quality.
Materials and Methods: Data were gathered during a randomized controlled clinical trial of 122 subjects from initial examination until 6-month follow-up. For this report, the direct costs of providing one set of conventional complete dentures by T or S techniques were estimated. All materials used were recorded and their cost was calculated in Canadian dollars (CAN$). The costs of fabrication in an outside laboratory were added. Clinician's labor time was recorded for every procedure. Between-group comparisons for each clinical procedure were carried out with independent *t*-tests. The number of patients in each group who needed postdelivery treatment was compared with Chi-square tests. The effect of group assignment and of treatment difficulty on outcomes was analyzed with multiple regression analysis.
Results: The mean total cost of the T method was significantly greater than S (CAN$166.3; $p < 0.001$), and clinicians spent 90 minutes longer ($p < 0.001$) on clinical care. The difficulty of the case had no significant influence on outcomes.
Conclusions: The results indicate that the S method is the more cost-efficient method and that there are no negative consequences that detract from the cost savings.

Although a number of clinical trials have shown that implant-retained complete mandibular overdentures opposed by a conventional maxillary complete denture improve patient satisfaction and quality of life,[1,2] between a quarter to a third of clinical trial participants were found to prefer conventional dentures over implant-supported prostheses.[3–5] Furthermore, the higher cost of implant overdentures makes conventional complete dentures the primary choice of patients of low-economic status[6–9] or when surgery is contraindicated or refused.

The traditional academic method (T) of fabrication of conventional dentures taught in most North American dental schools[10,11] is not used by most general practitioners in the United States[12] and United Kingdom.[13] They use simplified methods(S), and this has caused concern within the dental education community.[13] The S method may be preferred because it is easier to master than the T technique, and/or because it reduces costs. We compared the two techniques in a randomized controlled clinical trial. Our results[14] showed that T and S produce similar mean levels of patient satisfaction measured in a 100 mm visual analogue scale 6 months after delivery (T = 86; S = 86). Four prosthodontists who were blind to both group allocation and the purpose of the study, clinically assessed denture quality at the 6-month recall using objective criteria.[15] This showed that the two techniques produced dentures of equivalent quality (T = 66, S = 63).

In this article, we report on a detailed economic analysis of the T and S methods that includes microcosting (i.e., each component of resource use of materials, laboratory fee, and time are estimated, along with unit cost delivered for each[16]) to determine the most efficient allocation of resources in the fabrication of one set of conventional complete dentures from the clinical provider's perspective.[17,18] Subgroup incremental analysis of costs, time, and effect according to edentulous diagnostic classification[19] was also performed.

Materials and methods

The clinical trial

The trial was conducted between December 2000 and December 2002, with a follow-up through May 2003 at the Montreal General Hospital (Montreal, Quebec). A total of 128 male and female participants, aged 45 to 75 years, were enrolled in the trial. The protocol was approved by the McGill University Institutional Review Board, and informed written consent was obtained from all subjects. The subjects were stratified by a classification diagnostic system that indicated treatment difficulty[19] and then randomly allocated to either group using computer-generated random numbers in a concealed manner and using sealed envelopes to avoid bias. The details of the study conditions have been previously described.[14]

Fabrication procedures

The T and S procedures differed in the use of final impression method, face-bow, type of articulator, and the remount procedure. In the T group, a stock tray (McGowan, Coe GC America, Alsip, IL) and an alginate (Blueprint Cremix, Dentsply, York, PA) were used for the preliminary impression. The final impression was made with a custom tray, fabricated from a study cast, and border molded using impression compound (Type 1, Kerr, Orange, CA) and then a polyether rubber impression material (Impregum®, 3M ESPE, Minneapolis, MN). After occlusal registration, the cast was mounted on a semi-adjustable articulator (Hanau H2, Teledyne Water Pik, Fort Collins, CO) using a face-bow record. In the S group, a stock tray (McGowan) with alginate (Blueprint Cremix) was used for the final impression. The border of the denture was outlined on the cast by referring to the anatomical landmarks, and occlusal rims were prepared for occlusal registration. The cast was then mounted on a monoplane articulator (Apex #2 style, Lincoln Dental Supply, Cherry Hill, NJ).

Bilateral balanced occlusion was developed using artificial acrylic teeth (Bioform® IPN, Trubyte®, Dentsply). After the try-in session, the denture was delivered to the patients and three control appointments were scheduled. At the first control consultation, the remount procedure was performed only in the T group. Examinations beyond the third control (additional examination) and other unscheduled procedures (modification of denture, repairs, re-registration of occlusion, and direct or indirect reline) were defined as "additional procedures."

Material cost and time-measuring methodology

The material costs measured in the study are the direct costs of providing one set of conventional complete dentures by T or S techniques. Each component of the direct resource (i.e., disposable and nondisposable materials) was recorded, and market price was calculated in Canadian dollars (CAN$).[7] The costs of fabrication in an outside laboratory were also included. Clinician's labor time was recorded for every procedure. The time horizon of the analysis was 6 months after denture delivery. Costs incurred up to that time included costs of fabrication, scheduled consultations, and those arising from additional examinations and unscheduled procedures.

Statistical analysis

Between-group comparisons for each procedure and total material costs and clinician time were carried out with independent *t*-tests. The number of patients in each group who needed additional examinations and unscheduled procedures were compared with Chi-square tests. The effect of dependent variables (treatment difficulty on scheduled and unscheduled procedures, total cost, and time) was analyzed with multiple regressions using group (T and S) and difficulty of treatment[19] (Class I to IV) as independent variables. All analyses were carried out using STATA™ 9.2 (StataCorp, College Station, TX). An alpha level of 0.05 was set for significance.

Results

The baseline characteristics of the study population and sociodemographic status were comparable between the groups (Tables 1 and 2). There were no significant differences in patient satisfaction, their assessment of oral function, or evaluation of denture quality by prosthodontists between T and S groups.[14] A total of 119 subjects (58 T, 61 S) received new dentures, and 53 T and 55 S subjects attended the 3-month recall sessions, resulting in follow-up rates of 91.4% and 90.2%, respectively. At the 6-month recall sessions, the follow-up rates were 87.9% (51 T) and 88.5% (54 S). Figure 1 summarizes patient flow during the study.

Material cost and clinician time

Total scheduled time was 82 minutes longer, and total cost at delivery was CAN$173 more with the T method. As was expected, there were no differences in cost of materials or time associated with procedures common to both the T and S methods (initial examination, try-in, and delivery, Table 3). Final

Table 1 Baseline clinical characteristics of the groups

	T (n = 61)	S (n = 61)	*p*-value
Age, years (SD)	61 (7)	62 (7)	0.26[a]
No. of Female (%)	38 (62.3)	30 (49.2)	0.15[b]
Years edentulous (95% CI)			
Maxilla	33 (29, 36)	38 (35, 41)	0.02[a]
Mandible	36 (33, 39)	31 (28, 35)	0.05[a]
Number of previous dentures (95% CI)			
Maxillary	4.2 (3.7, 4.8)	3.9 (3.3, 4.4)	0.32[a]
Mandibular	4.1 (3.5, 4.7)	3.7 (3.1, 4.2)	0.25[a]
General satisfaction- Visual analogue scale mm (95% CI)			
Overall	46 (38, 54)	46 (39, 53)	0.98[a]
Maxillary	59 (50, 68)	62 (54, 69)	0.67[a]
Mandibular	33 (25, 41)	34 (26, 42)	0.87[a]
Native tongue French no. (%)			
	59 (96.7)	57 (93.4)	0.32[b]
Diagnostic classification (%)[c]			
Class I	8 (13.1)	8 (13.1)	–
Class II	13 (21.3)	13 (21.3)	
Class III	22 (36.1)	22 (36.1)	
Class IV	18 (29.5)	18 (29.5)	

[a]Independent *t*-test. [b]Chi-squared test. CI = confidence interval. [c]Equal numbers were allocated to T and S.

Table 2 Baseline socio-demographic characteristics of the groups

	T (n = 61)	S (n = 61)	*p*-value
Civil status (%)[a]			
Single	9 (15)	9 (14.8)	0.45[b]
Married	40 (66.7)	39 (63.9)	
Separated	11 (18.3)	13 (21.3)	
Family structure (%)[a]			
Alone	13 (21.7)	16 (26.2)	0.85[b]
With family	38 (63.3)	36 (59.0)	
Other	9 (15)	9 (14.8)	
Education (%)[a]			
Elementary	4 (6.7)	3 (4.9)	0.79[a]
High school	15 (25)	22 (36.1)	
College	17 (28.3)	14 (23)	
University	23 (38.3)	21 (34.4)	
Other	1 (1.7)	1 (1.6)	
Employment (%)[a]			
Full-time	8 (13.3)	16 (26.2)	0.34[b]
Part-time	6 (10)	7 (11.5)	
Unemployed	3 (5)	1 (1.6)	
Retired	35 (58.4)	30 (49.2)	
Other	8 (13.3)	7 (11.5)	
Income (CAN$) (%)[a]			
>20,000	8 (13.3)	4 (6.5)	0.50[b]
20,000 to 30,000	11 (18.3)	7 (11.5)	
30,000 to 40,000	10 (16.7)	14 (23.0)	
40,000 to 60,000	12 (20.0)	16 (26.2)	
60,000 to 75,000	2 (3.3)	7 (11.5)	
Refused to answer	17 (28.4)	13 (21.3)	

[a]One T subject did not answer. [b]Chi-squared test.

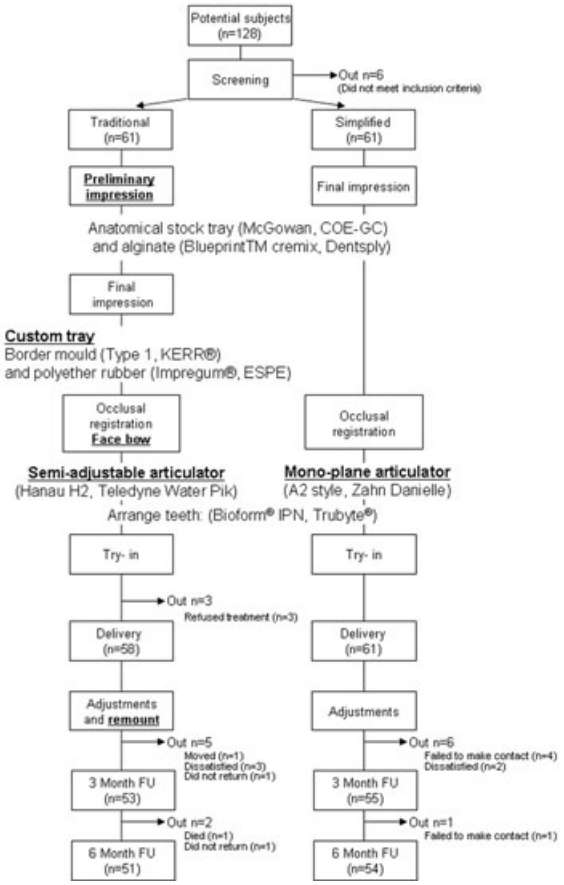

Figure 1 Fabrication procedures and patient flow of the study.

impressions took approximately 32 minutes longer with the T method, and extra materials were used (CAN$9.4). Although the additional material cost of occlusal registration was significantly higher for the T method, the difference was only 20 cents, and there was no difference in clinician time for this stage. The clinician took about 23 minutes longer for the postdelivery examination with the T method, and it cost more. Laboratory fees were CAN$159 more for the T method.

About one-third of the subjects (22 T, 20 S) required additional examinations, and unscheduled procedures were required by 4 T and 9 S subjects. The differences in the frequency of additional examinations ($\chi^2 = 0.34$; $p = 0.55$) and unscheduled procedures (*Repair*: T: 0, S: 2; *Direct or indirect reline:* T: 4, S: 5; *Re-registration of occlusion:* T: 0, S: 2; $\chi^2 = 1.89$; $p = 0.24$; Fisher's exact test) were not significant, and there were no significant differences in cost or in clinician time between groups for this stage (Table 3). The proportion of additional cost to total cost for T and S were 1.7% and 2.8%, respectively, while additional time spent was 16% (T) and 19% (S) of total time.

The final mean total cost of the T method was significantly greater (CAN$166.1: 23% > S), and clinicians spent 90 minutes longer (36% > S) on clinical care. Regression analysis revealed that group assignment had significant influence on scheduled procedures, total cost, and time, whereas diagnostic classification had no significant effect on scheduled procedures, additional procedures, total cost, or time. The apparent difficulty of the case had no significant influence on cost or time for scheduled or additional procedures (Table 4).

During the period in which the clinical trial occurred, the mean suggested base fee for a set of complete dentures was CAN$1163 plus laboratory costs (the Quebec Association of Dental Surgeons' fee guide). If this fee had been charged and material costs deducted, the hourly return on the T method would have been CAN$199.5 and CAN$274.5 on the S treatment.

Discussion

This microcosting study shows for the first time that the T method of denture fabrication generally favored by academic prosthodontists is significantly more costly in materials and laboratory costs (24.5%). In addition, it takes approximately 36% more time than the S method widely used in general practice. This is important because we found no evidence that the T method produces greater patient satisfaction, better function or higher quality, even for cases classified as difficult-to-treat based on diagnostic findings.[19]

Lewis[20] recommended that a comparative economic analysis be undertaken to establish the relative costs and consequences

Table 3 Material and laboratory costs and clinician's time for T and S

	Cost (CAN$) Mean (SD)		Mean difference		Clinician's time (minutes) Mean ± SD		Mean difference	
	T (n = 58)	S (n = 61)	(95% CI)[a]	T/S	T (n = 58)	S (n = 61)	(95% CI)[a]	T/S
A. Scheduled procedures								
Materials								
- Initial examination	0.6 (0.0)	0.6 (0.0)	0 (0.0, 0.0)	1.0	15 (9)	13 (9)	2 (−1.1, 5.2)	1.2
- Preliminary impression	2.5 (0.3)	ø†			7 (4)	†		
- Final impression	12.2 (0.9)	2.8 (0.5)	9.4 (9.1, 9.7)**	4.4	53 (4)	21 (5)**	32 (28.4, 34.9)**	2.5
- Occlusal registration	1.2 (0.3)	1.0 (0.4)	0.2 (0.03, 0.3)*	1.2	38 (9)	37 (10)	1 (−1.9, 4.8)	1.0
- Try in	1.3 (1.7)	1.1 (0.8)	0.2 (−0.2, 0.7)	1.2	32 (26)	27 (26)	5 (−5.1, 13.8)	1.2
- Delivery	3.0 (1.3)	2.8 (0.7)	0.2 (−0.1, 0.6)	1.1	40 (19)	40 (12)	0 (−5.3, 6.2)	1.0
- Postdelivery examination‡	6.8 (2.8)	5.5 (3.4)	1.2 (0.1, 2.4)*	1.2	90 (43)	67 (39)*	23 (8.8, 38.9)*	1.3
Laboratory fees	851	692	159	1.2				
Subtotal	878.6 (4.7)	705.8 (4.3)	172.8 (171, 175)**	1.3	285 (70)	203 (60)**	82 (58.3, 105.6)**	1.4
B. Additional procedures§								
Materials								
- Additional examination	3.5 (8.1)	3.2 (9.2)	0.4 (−8.2, 7.5)	1.1	47 (110)	33 (90)	14 (−22.4, 50.4)	1.4
- Unscheduled procedures	0.6 (2.4)	1.1 (3.1)	−0.5 (−1.5, 0.5)	0.5	8 (40)	14 (45)	−6 (−22.7, 9.2)	0.6
Laboratory fees	9.5 (36)	16 (40.6)	−6.5 (−20.4, 7.4)	0.6				
Subtotal	13.6 (40.6)	20.3 (47.9)	−6.7 (−22.8, 9.5)	0.7	55 (116)	47 (115)	8 (−34.2, 49.8)	1.2
Mean total cost/time	892.1 (41)	726.0 (50.3)	166.1 (149, 183)**	1.2	340 (156)	250 (160)	90 (32.4, 147.1)**	1.4

* $p < 0.05$, ** $p < 0.01$.

[a]Independent *t*-tests.

†Does not apply.

‡Two S subjects did not attend scheduled postdelivery examination.

§Mean cost and time has been calculated with 58 T and 61 S; 22 T and 20 S required additional examinations; 4 T and 9 S required unscheduled procedures. CI = confidence interval.

of prosthetic interventions to accompany measures of clinical effectiveness. For clinicians, cost of providing therapy is a major concern when deciding between treatment alternatives, because they must balance treatment efficacy, direct cost, and time needed to treat, and profit;[17,18] however, selecting treatment alternatives based on cost may result in inappropriate care.[17] Fortunately, this does not seem to be the case here, because we have already shown that dentures fabricated with the S and T methods give equivalent patient satisfaction.[14] Furthermore, prosthodontists gave similar ratings of denture quality to S and T dentures.

Other data on cost of dentures mostly comes from studies comparing conventional (T method) and implant overdentures.[7,21,22] Total clinician's time with the T method in our study (340 minutes) was higher than the 239 minutes reported by Takanashi et al;[21] however, they did not include the initial examination and additional procedures, which took 15 and 55 minutes, respectively, in our study. Other estimates for the T method were also in the 300 minutes range (308 minutes).[22,23]

When we analyzed the resources and time invested in the two procedures, the use of additional resources was mainly attributed to the final impression and scheduled control sessions.

Table 4 The effect of group and diagnostic classification on scheduled, additional procedures, and total cost and time

	Independent variables coefficients (95% CI[a], *p*-value)	
Dependent variables	Group	Classification
Cost		
Scheduled procedures	−173 (−175, −171, $p < 0.01$)	0.6 (−0.2, 1, $p = 0.2$)
Additional procedures	6.7 (−10, 23, $p = 0.4$)	0.4 (−7, 8, $p = 0.9$)
Total	−166 (−183, −149, $p < 0.01$)	1.0 (−7, 9, $p = 0.8$)
Time		
Scheduled procedures	−82 (−105, −58, $p < 0.01$)	11 (−1, 22, $p = 0.07$)
Additional procedures	−8 (−50, 34, $p = 0.7$)	9 (−12, 30, $p = 0.4$)
Total	−90 (−147, −32, $p < 0.01$)	19 (−9, 48, $p = 0.2$)

[a]Independent *t*-tests.

CI = confidence interval.

In the T method, final impressions are made with polyethylene rubber and impression compound, which adds to the cost of materials (CAN$9.39) and increases clinician time (30 minutes). During the scheduled control visit, remount procedures are performed with the T method, which adds significantly to clinician time (24 minutes) and material costs (CAN$1.24). The higher laboratory fee for the T method (CAN$159) is related to the manufacture of custom trays and the use of semi-adjustable articulators.

Carlsson[24] reported that 80% to 90% of complete denture wearers were satisfied with their dentures, irrespective of denture quality. Only 13 of the initial 119 dentures (11%) of our subjects needed unscheduled procedures, and, although the rate was slightly higher in the S group (15% vs. 7%), there were no significant differences in cost or clinician time between the groups. We have already shown that the S method does not result in lower general satisfaction or denture quality than the T method.[14] The current study suggests that use of the S method does not result in the investment of additional resources to resolve complications. Furthermore, we found that a majority of patients' problems could be solved within 3 months, irrespective of either fabrication method used in this study.

It could be argued that the T method would be most beneficial for the more complex cases, for example, classes III and IV.[19] If this were true, the T method would have shown lower cost, less time, and/or fewer additional procedures for the more complex cases in this study; however, we found no evidence of this. The regression coefficients indicate that the complexity of the case did not increase or decrease cost or time significantly, and it had no influence on cost or time of additional procedures.

We will continue to measure patient satisfaction, cost of denture maintenance, and time to replacement, to determine which fabrication method provides the best long-term outcome. We hope these findings will assist dentists in providing cost-effective care to denture wearers. These findings should also contribute to evidence-based curriculum reform.

Conclusions

Within the limitations of this study, the results indicate that the S method is the more cost-efficient method and that there are no negative consequences that detract from the cost savings.

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