Mandibular Overdentures: Professional Time for Prosthodontic Maintenance During the First Year of Service Using Three Different Implant Systems

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Purpose: The purpose of this study was to evaluate the professional time required for the prosthodontic maintenance events of mandibular implant overdentures during the first year of service using three different implant systems (ITI, Steri-Oss, or Southern). **Materials and Methods:** Seventy-two mandibular implant overdenture patients were allocated to three equal groups, each treated with a different implant system. Data on prosthodontic maintenance events during the first year were categorized and analyzed according to professional time allocation per procedure. **Results:** The total professional time required to perform all the maintenance events ranged between 29.0 and 34.0 hours and did not differ significantly among the three groups, although there were time differences for matrix activation and replacement. When combining the professional time for all maintenance events for the mandibular overdentures alone, or with the opposing maxillary complete dentures, there were no significant differences between groups. For maintenance of the maxillary dentures, there was an unexplained difference between the Southern group and ITI or Steri-Oss groups ($P < .05$). **Conclusion:** The prosthodontic maintenance for mandibular implant overdentures required on average 72 to 98 minutes of professional time per patient during the first year of service, depending on the system used. *Int J Prosthodont 2002;15:379–384.*

The application of business principles in prosthodontic practice has been addressed by Marchack,[1] who stated that, "The major difference between the provision of dental services and the manufacture of goods is that in dentistry the unit of production is time instead of a manufactured product." Furthermore, a service provided where no professional charge is made to the patient can be termed an "opportunity cost."[1] In this respect, the cost of maintenance of implant overdentures is not only that of the procedure, but also the profit foregone by missing the opportunity of performing another service that could be charged for. Assuming that this philosophy is correct, the measurement of professional time required to provide the prosthodontic maintenance for mandibular implant overdentures may provide an insight into the cost component of that treatment. The prosthodontic maintenance of mandibular implant overdentures takes into account both clinical and laboratory time, which should be identified before commencing treatment.[2] When proposing implant overdenture treatment to potential patients, a misjudgment of the professional time may result in treatment exceeding the initial time allocated and therefore the professional fee quoted.[3] In such cases, the prosthodontist pays for the opportunity to treat the patient, and providing the treatment becomes uneconomic.

Although implant overdentures may be recommended for patients presenting with limited budgets,[4,5]

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Table 1 Professional Time Associated with Individual Maintenance Events for Mandibular Implant Overdentures

Maintenance event	Time allocation per procedure (min)	Steri-Oss		Southern		ITI	
		Events	Total time (min)	Events	Total time (min)	Events	Total time (min)
Patrix loose	30	3	90				
Matrix housing dislodged							
Mechanical replacement	30					10	300
Laboratory procedure	60 (2 × 30)	18	1080				
Matrix activated	15					18	270
Matrix replaced							
Mechanical replacement	15	58	870			24	360
Laboratory procedure	60 (2 × 30)			20	1200		
Matrix fractured	See "matrix replaced"					10	
Fractured implant denture or fracture of denture teeth	60 (2 × 30)			3	180	3	180
Reline denture	60 (2 × 30)			6	360	10	600
New denture	180 (6 × 30)					1	180
Total			2040 (34 h)		1740 (29 h)		1890 (31.5 h)

there has been concern that the prosthodontic maintenance may outweigh their assumed cost-benefit advantage as opposed to an implant-fixed prosthesis.[6–10] Walton and MacEntee[10] studied the comparative maintenance of implant-fixed prostheses and implant overdentures in private practice and found the repair costs to be approximately 60% higher for the latter. Comparative studies of the actual professional time taken for prosthodontic maintenance of implant overdentures using different systems are not common,[11,12] as there are more studies that quantitatively identify only the differences in the extent of maintenance between systems.[13–16]

The aim of this study was to evaluate the professional time required for prosthodontic maintenance procedures for mandibular implant overdentures during the first year of service using three different implant systems.

Materials and Methods

Patients

Seventy-two edentulous patients (age 55 to 80 years, mean 65 years; 42 women and 30 men) were selected from the Clinical Overdenture Research Project (CORP), School of Dentistry, University of Otago, Dunedin, New Zealand. They were randomly allocated into three groups of 24 patients, with each group treated with a different implant system (Steri-Oss, Nobel Biocare; ITI dental implant system, Straumann; Southern Implants). Ethical approval for the study was obtained from the Otago Ethics Committee, and all participants gave informed consent. Inclusion criteria required patients to have sufficient bone volume and suitable bone quality in the anterior mandible, as assessed radiographically,[17] to receive two implants of 12- to 15-mm length and up to 4.1-mm diameter.

Surgical and Prosthodontic Procedures

Standardized clinical and laboratory prosthodontic procedures were followed for the fabrication of the maxillary and mandibular complete dentures[18,19] prior to implant placement. Implants were placed in the mandible 11 mm to either side of the midline symphysis. Following implant placement, each patient did not wear their mandibular complete denture for 2 weeks, after which the dentures were relieved and lined with a tissue conditioner. Following the healing period for osseointegration, the mandibular dentures were permanently relined with acrylic resin to include the matrices. All matrix and patrix components were placed according to the manufacturers' instructions. The Steri-Oss system included a ball abutment (patrix) and a rubber O ring (matrix); the Southern Implants included an overdenture abutment (patrix) and a plastic cap (matrix); and the ITI system included a retentive anchor (patrix) and either the gold-alloy matrix or titanium-alloy matrix with a stainless steel spring. No activation or deactivation of the matrices was done by the dental technicians or clinicians prior to the delivery of the mandibular implant overdentures.

Prosthodontic Maintenance

Data pertaining to the number of prosthodontic maintenance events needed during the first year were categorized by procedure and recorded (Table 1). They included patient-initiated requests or professionally determined needs at the annual recall. Patrix and

Table 2 Professional Time Associated with Individual Maintenance Events for Maxillary Complete Dentures

Maintenance event	Time allocation per procedure (min)	Steri-Oss		Southern		ITI	
		Events	Total time (min)	Events	Total time (min)	Events	Total time (min)
Patient complaint about retention	30			6	180	1	30
Reline denture	60 (2 × 30)			5	300		
Denture adjustment							
Phonetic complaint	30	2	60	3	90		
Esthetic complaint	30	1	30	1	30		
Lip/cheek biting complaint	30	2	60	1	30		
Total			150		630*		30

*$P < .05$; one-way analysis of variance: The Southern group differed from the other two.

matrix maintenance were considered separately. Overdenture fractures, puncture fractures, denture teeth fractures, and relines or remakes of the implant overdenture were all categorized as additional maintenance. Details of denture eases (adjustments to contour) and periimplant or interabutment mucosal enlargement were not included.[20,21] The need for relining the mandibular overdenture was assessed according to one or more of the specific criteria defined by Payne et al.[21] The inclusion of the prosthodontic maintenance requirements for the maxillary denture was justified on the grounds that there is a responsibility for the prosthodontist to provide maintenance for both prostheses for an edentulous patient rehabilitated in this manner. Complaints about retention, the need for relines, and any esthetic, phonetic, or lip/cheek biting complaints related to the opposing maxillary denture would no doubt incur some laboratory costs and possibly professional costs. This could include elimination of speech or esthetic complaints, which would require palatal contour modification, stripping and resetting some teeth, or remaking the maxillary denture. This takes additional professional time.

A professional time analysis was done for the prosthodontic maintenance in the first year for the three different implant systems. Allocations of professional time of 15 or 30 minutes each were made based on the length of time needed to perform each of the maintenance events. For the categories "matrix activated" and "matrix replaced" with no laboratory procedure, 15 minutes was allocated. Some procedures required more than one appointment, and these were recorded accordingly. It was the view of the authors that these prosthodontic maintenance visits would not be done on an "add-on" emergency basis in a private prosthodontic practice. This would only pertain to denture eases, which were excluded from this study for that reason.

Statistical Analysis

The numbers of maintenance events that were recorded for each implant system in each category were multiplied by the respective time allocations (excluding laboratory time) to give the total amount of professional time required per system. This provided cumulative data on the professional time required for maintenance of each implant system during the first year of service. This figure was then divided by the number of patients in each group to give means for comparison among the different implant systems. Differences among mean maintenance times were tested for statistical significance using the Mann-Whitney *U* test.

Results

The professional time required for prosthodontic maintenance of the mandibular implant overdentures is shown in Table 1. There was up to 5 hours of difference of professional time between systems (29 to 34 hours), but this difference was not statistically significant. There were, however, time differences between implant systems for individual events, most notably for matrix activation, replacement, or fracture. The repair of dislodged matrix housings, particularly in the Steri-Oss group, was the most time-consuming event. Time for the maintenance of the maxillary complete denture was significantly higher for the Southern group than for the ITI or Steri-Oss groups (Table 2). When combining the time for all maintenance events for the mandibular overdenture alone or with the opposing maxillary complete denture, there were no significant differences between the implant systems and a professional time requirement of 72 to 98 minutes per patient (Table 3).

Discussion

This study has shown that the prosthodontic maintenance time associated with different implant systems using unsplinted designs of mandibular overdentures during the first year of service is notable. If this pattern is maintained for 5 to 10 years, whether there is an economic indication for choosing an implant

Table 3 Estimated Professional Time Associated with Combined Maintenance Events for Mandibular Overdentures and Maxillary Complete Dentures

Group	Total time	Time per patient
Mandibular overdenture only		
Steri-Oss	34 h	1 h 25 min
Southern	29 h	1 h 12 min
ITI	31 h 50 min	1 h 18 min
Both dentures		
Steri-Oss	36 h 50 min	1 h 31 min
Southern	39 h 50 min	1 h 38 min
ITI	32 h	1 h 20 min

overdenture design over an implant-fixed prosthesis may be questioned by some authors.[6] It needs to be emphasized that each implant system needed different types of repairs, some of which included the need for ordering additional implant components or using laboratory facilities. The patients' overdentures were out of service during that laboratory time.

It could be argued that some of the prosthodontic maintenance events might not have taken the allocated 30 minutes. However, an attempt was made to simulate, as closely as possible, appointment times in a private prosthodontic practice. Some of the procedures may have taken only 20 minutes, but if 30 minutes had been scheduled, then the remaining 10 minutes could still be considered an opportunity cost (ie, foregone profit by missing the opportunity of providing another service[1]). Patients in this study generally telephoned requesting activation or replacement of the matrix component, and in these instances, because these maintenance events were routinely achieved in 15-minute appointments, this shorter appointment was scheduled. It is a point of debate as to whether the 15-minute appointments would be scheduled or be add-on emergencies. However, it is possible that in a private prosthodontic practice, the prosthodontic maintenance events could be scheduled to a less productive time of the day (at the end of the day, for example), thereby minimizing the opportunity cost. An alternative option of recording the actual time for each procedure was considered unrealistic in this context.

Comparison of our findings with those of others is not completely possible because of differences in study design. In our study, prosthodontic monitoring started immediately after insertion of the overdenture, while others started after 6 weeks[12] or 3 months,[11] presumably to allow for denture eases and adaptation. In only one respect were the findings of this study similar to those of Wismeijer et al,[11] in that a considerable amount of time was required for maintenance of the matrices. This result can also be compared with that from Canadian private prosthodontic practices, where over a 22-month period the time required was 1.15 to 2.36 hours for adjustments (patrix/matrix maintenance) and repairs (fractures, relines, remakes).[10] Early reports on implant-fixed prostheses identified between 38 and 60 minutes of maintenance per prosthesis per year.[22,23] A surprising finding was the greater time associated with the maintenance of the maxillary complete dentures in the Southern group. It is difficult to account for this difference, and type I error could be involved; that is, it may be that the significant finding arose simply by chance because of the number of statistical tests performed.[24] Alternatively, those cases may simply have had more severely resorbed maxillary ridges. Differences in clinical decisions among dentists[25] also apply to prosthodontic practice and would have a bearing on the use of the findings of this study. Examples of this could include decisions on the need for matrix activation and replacement or in determining the need for relines.[26]

Extrapolation of economic considerations may include both direct and indirect costs.[27] Prosthodontic maintenance is a direct cost. Indirect costs include travel costs to the treatment center and the loss of income because of absence from work.[28] However, when comparing the costs of prosthodontic maintenance of implant systems, it is simpler to measure the direct costs only; the indirect costs do not change with the different systems if all other aspects of the treatment process are the same. Moreover, the indirect costs are not incurred by the prosthodontist. There is a problem relating care in an academic setting with care in a private prosthodontic practice. Many factors could influence the cost of care and prosthodontic maintenance needs. The experience of the providers is critical, and in an academic setting may range from students, graduate students, and junior staff to experienced prosthodontists. The background of the patients seeking care at one place or another might be different, and so their expectations of both treatment outcomes and costs could differ.

By measuring the time required to perform a procedure, its cost effectiveness can be analyzed.[29] Researchers in the Netherlands[11,12] have identified the complexity of evaluating the cost of overdenture treatment in an academic setting, but there is difficulty in relating such analyses to private prosthodontic practice. However, it could be argued that many of these costs are likely to be similar to the private practice setting, with the only difference being the fee for service charged by privately practicing prosthodontists. One estimate of professional costs per hour, which was derived from a survey of private prosthodontic practices in the United States,[30] gave

an hourly gross of US $300 and may be open to debate. This figure may seem unrealistically low to some readers, and each private prosthodontist has his or her own idea of hourly professional fees.

It is important to the success of prosthodontic treatment that the total cost be clearly estimated before commencing treatment. A proposed outline for a confirmation letter for private prosthodontic patients[31] states that it is often not possible to map the entire course of treatment because all elements in the course of care are not known. The need for professional time for maintenance events with mandibular overdentures should be described before treatment begins, and each prosthodontist should multiply by what they charge for an hour's work. This could be a source of competitive advantage for the prosthodontist,[32] since payment for prosthodontic maintenance events after overdenture insertion could be viewed with disfavor by some patients.

The prosthodontic maintenance for mandibular implant overdentures required on average 72 to 98 minutes of professional time per patient during the first year of service, depending on the system used.

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Literature Abstract

Fracture strength of four different types of anterior 3-unit bridges after thermo-mechanical fatigue in the dual-axis chewing simulator.

Three-unit anterior fixed partial dentures (FPD) were fabricated using four different systems with their respective veneering porcelains. A galvano-ceramic system (AGC, Galvanotechnik), a glass-infiltrated system (Celay In-Ceram Alumina, Mikrona), and a lithium disilicate glass-ceramic system (Empress 2, Vita) were investigated, using a conventional metal-ceramic system (Degudent, Degussa) as a control. Sixty-eight caries-free human maxillary central and lateral incisors were selected and cleaned, with one central and one lateral incisor embedded about 8.5 mm apart in an autopolymerizing polyester resin. All roots were coated with gum resin to simulate the periodontal ligament. Frameworks for the four systems had similar designs, except for the dimensions of the connector. All completed prostheses were cemented using an autopolymerizing composite before dynamic loading at 25 N and 1.3 Hz with synchronized thermocycling in a dual-axis chewing simulator, which performed 1,200,000 chewing cycles to correspond to a 5-year service time. Samples that did not fracture at the end of the chewing simulation were examined for incipient fractures under stereomagnification before loading to fracture under a universal testing instrument. None of the galvano-ceramic or metal-ceramic prostheses fractured during dynamic loading, indicating a 100% survival rate at 5 years. Fracture of five In-Ceram Alumina and two Empress II prostheses during dynamic loading indicated a survival rate of 75% and 37.5%, respectively. The metal-ceramic system had significantly higher fracture load compared to the other three systems. Fracture load of Empress II was not significantly different from In-Ceram Alumina or AGC. However, AGC had significantly higher fracture load than In-Ceram Alumina. The authors claimed that incisive biting forces are about 290 N. Thus, In-Ceram Alumina might not be a suitable material for anterior FPDs, whereas Empress II and AGC might be adequate. Failure occurred at the connectors for the two ceramic systems in both static and dynamic loading. Therefore, strengthening the connectors by increasing their dimensions, or incorporating zirconia in the case of In-Ceram Alumina, might improve the survivability of these systems. Long-term clinical studies are still needed to provide reliable survival and strength characteristics data.

Kheradmandan S, Koutayas SO, Bernhard M, Strub JR. *J Oral Rehabil* 2001;28:361–369. **References:** 79. **Reprints:** Dr S. Kheradmandan, Department of Prosthodontics, School of Dentistry, Albert-Ludwigs University, Hugstetterstrasse 55, Freiburg 79106, Germany. e-mail: strub@zmk2.ukl.uni-freiburg.de—*Kok-Heng Chong, Ann Arbor, Michigan*