Implant Dentistry in the Undergraduate Dental Education Program at Dalhousie University. Part 1: Clinical Outcomes

Mats Kronstrom, DDS, PhDa/Lisa McGrath, BScb/Douglas Chaytor, DDS, MS, MEd, MRCD(C)c

Purpose: This study evaluated the outcome of treatments performed by students in the undergraduate implant elective program at Dalhousie University. Materials and Methods: All patients treated with dental implants in the undergraduate elective program at the Faculty of Dentistry, Dalhousie University, Halifax, Nova Scotia, Canada, between 1994 and 2004 were identified from patient records. Brånemark implants (Nobel Biocare) were placed by experienced oral and maxillofacial surgeons or periodontists using the traditional 2-stage protocol and an intermediate healing period of 3 to 6 months. Undergraduate students in the elective implant program were responsible for the restorative part of the treatment. *Results:* A total of 166 implants were placed in 95 patients (38 men, 57 women; mean age: 52 years, range: 18 to 84 years). Of the 166 implants, 142 had been restored at the time of the study. Ten of the implants failed: 4 were lost during healing and the remaining 6 were lost after loading, leading to an implant survival rate of 93%. A total of 64 single-implant restorations, 7 multiple-unit fixed restorations, and 33 implant overdentures were fabricated. Conclusion: The results indicate that the clinical outcome of implant treatments performed by undergraduate students in the implant elective program at Dalhousie University is similar to that reported by experienced clinicians/research teams. Although the implant surgery was performed by an experienced oral and maxillofacial surgeon or periodontist, the student had the main responsibility for treatment planning and performing the prosthodontic procedures. The results also suggest that implant dentistry could be implemented as part of the curriculum in the undergraduate programs of dental schools. Int J Prosthodont 2008;21:124-128.

The use of dental implants to provide support for fixed and removable prostheses is considered a predicable and successful treatment modality.^{1–5} This has resulted in a high demand for implant-training courses, and several universities and education centers in North America are offering didactic and hands-on implant-training programs for general practitioners.⁶ The success of dental implants has certainly changed traditional prosthetic dentistry and opened up new perspectives and viable treatment options for partially and completely edentulous individuals.

Most dental schools in North America have included implant dentistry as part of the curriculum in their predoctoral education programs. However, there is a great variation in how the training programs are designed.⁷⁻¹¹ Most schools have a didactic part and a laboratory instruction course included in the curriculum, and the majority allow undergraduate students to perform the restorative part of implant treatment.^{7,8,10} Moreover, some schools offer an elective program, with the intention of providing the students with greater knowledge in implant dentistry.¹¹ There is evidence that dental clinicians who gained laboratory and/or clinical implant experience in their undergraduate training program are more likely to include treatments with implants in their dental practice.¹²

^aAssociate Professor, Department of Restorative Dentistry, University of Washington, Seattle, and Department of Dental Clinical Sciences, Faculty of Dentistry, Dalhousie University, Halifax, Nova Scotia, Canada.

^bSenior Dental Student, Department of Dental Clinical Sciences, Faculty of Dentistry, Dalhousie University, Halifax, Nova Scotia, Canada.

^cProfessor Emeritus, Department of Dental Clinical Sciences, Faculty of Dentistry, Dalhousie University, Halifax, Nova Scotia, Canada.

Correspondence to: Dr Mats Kronstrom, Department of Restorative Dentistry, School of Dentistry, University of Washington, PO Box 357456, Seattle, Washington 98195-7456. Fax: 206 543 7783. E-mail: mk33@u.washington.edu

From a didactic point of view, it is important to evaluate not only the clinical outcome of treatments performed by undergraduate dental students, but also patients' opinions regarding the treatments. There is sparse information in the literature on outcomes from treatments performed by undergraduate students; however, survival rates of implants placed by facultystudent teams appear to be comparable with those presented from various implant centers.^{11,13,14}

In 1994, an elective program in implant dentistry was initiated at Dalhousie University Faculty of Dentistry in Halifax, Nova Scotia, Canada. The objectives of the study were to present outcomes after treatment with dental implants between the years 1994 and 2004 and to evaluate patients' opinions regarding treatment. This first part of the study will report on the clinical outcome.

Materials and Methods

All patients treated with dental implants in the elective program at the Faculty of Dentistry of Dalhousie University between 1994 and 2004 were identified from patient records. The patients had been referred from either the student clinic at the Faculty of Dentistry or from general practitioners in Nova Scotia. Each patient was screened by a prosthodontist to evaluate whether he or she was a suitable candidate for implant treatment, and if needed, a consultation was made with an oral and maxillofacial surgeon. Typically, this procedure aimed to select patients who would be amendable to treatment by a competent general practitioner in his or her office. Patients considered suitable for treatment were assigned to students in the Elective Implant Program. The students' responsibility included a thorough clinical examination including a review of the patient's medical and dental history, establishing the definitive treatment plan, and performing the restorative phase of the treatment. The final treatment plan included a predetermination of the overall cost, and an estimated timeline for the treatment was established in collaboration with an instructor in the implant program. Prior to implant surgery, the student had to prepare a surgical guide, provide appropriate provisional restorations, order all implant components and surgical drill kits, and book the patient for implant surgery and postoperative appointments. Students' responsibility also included assisting the surgeon during implant placement and adjusting/relining the provisional restoration after stage 1 surgery and abutment connection.

All patients received Brånemark System implants (Nobel Biocare), and the implants were placed by experienced oral and maxillofacial surgeons or periodontists using the traditional 2-stage protocol and an intermediate healing period of 3 to 6 months. Final impressions were made approximately 4 to 5 weeks after abutment connection once proper soft tissue healing had been completed. All implants supporting an overdenture were splinted using a cast gold alloy bar, and each denture was designed with 2 clips for retention. The implant crowns and multiple-unit fixed restorations were fabricated using high noble gold alloy with porcelain veneers. The majority of the fixed restorations were screw retained to the implant. A baseline radiographic examination was performed at the time of prosthesis delivery, and hygiene instructions were provided. All patients were included in an annual recall system.

For research purposes, it was decided to extract the type of information that is usually considered appropriate in retrospective studies of dental implants. For each patient, the following information was available:

- Age
- Sex
- Type of prosthesis
- · Type, length, and diameter of implants
- Implant surface texture
- Implant position
- Observation period
- Baseline radiographic evaluation

The yearly follow-up examinations included:

- · Changes in peri-implant bone level
- Implant stability
- · Oral hygiene status
- · Soft tissue condition
- Denture fit (overdentures)
- · Evaluation and adjustment of occlusion if necessary

Information about complications related to the implant treatment was also recorded from patient charts.

Statistical Analysis

Data were analyzed in frequency tables, and the life table technique was used for survival analysis. All data analysis was carried out using SPSS software (SPSS Institute).

Results

A total of 166 implants were placed in 95 patients (38 men and 57 women; mean age: 52 years, range: 18 to 84 years). Most commonly, 13-mm-long implants were placed, and Mk II and Mk III implants were predominantly used (Tables 1 and 2). Of the implants, 6 (3%) were 3.3-mm-diameter narrow-platform (NP), 116 (70%) were 3.75-mm-diameter regular-platform (RP), 21 (13%) were 4-mm-diameter RP, and 23 (14%) were 5-mm-diameter wide-platform (WP).

Table 1 Length of Implants

Length (mm)	No.
8.5	5 (3%)
10	32 (19%)
11.5	21 (13%)
13	64 (38%)
15	36 (22%)
18	8 (5%)
Total	166

Table 2 Types of Implant

Туре	No.
Standard*	8 (5%)
Mk II*	75 (45%)
Mk III [§]	74 (44%)
Mk IV [§]	9 (5%)
Total	166

*Machined surface. §TiUnite surface.

Table 3 Life-Table Analysis

Observation period (mo)	No. of implants	No. of implants exposed to risk	No. of failed implants	Proportional survival rate (%)	Cumulative survival rate (%)
≤11	166	150.5	7	95.4	95.4
12-23	128	114	3	97.4	92.8
24-35	97	84	0	100	92.8
36-47	71	60.5	0	100	92.8
48-59	50	46	0	100	92.8
60-71	42	33.5	0	100	92.8
72-83	25	21	0	100	92.8
84-95	17	12	0	100	92.8
96-107	7	4	0	100	92.8
≥ 108	1	0.5	0	100	92.8

 Table 4
 Observation Period, Position, Length, Type, and Position of Failing implants (n
 = 10)

Observation period (mo)	Planned treatment	Position	Implant length/ diameter (mm)	Implant type/ surface texture
1	Single-tooth restoration	Maxillary lateral incisor	15/3.75	Mk II/machined
2	Overdenture	Mandibular first premolar	13/3.75	Mk II/machined
3	Single-tooth restoration	Mandibular molar	11.5/5	Mk III/TiUnite
3	Single-tooth restoration	Mandibular lateral incisor	15/3.75	Mk III/TiUnite
6	Multi-unit restoration	Mandibular lateral incisor	13/3.75	Mk III/TiUnite
8	Overdenture	Mandibular first premolar	13/3.75	Mk II/machined
9	Single-tooth restoration	Mandibular first premolar	15/3.75	Mk II/machined
14	Single-tooth restoration	Mandibular molar region	10/5	Mk III/TiUnite
16	Single-tooth restoration	Mandibular molar region	10/5	Mk III/TiUnite
16	Overdenture	Mandibular first premolar	13/3.75	MkII/machined

Of the 166 total implants placed, 142 had been restored at the time of the study. Ten of the implants failed: 4 were lost during healing and the remaining 6 were lost after loading, resulting in an implant survival rate of 93% (Table 3). Six of the failures occurred in the posterior mandible, 3 occurred in the anterior mandible, and 1 occurred in the maxillary anterior region (Table The vast majority of the treatments were single-implant restorations, followed by implant overdentures and multiple-unit restorations (Table 5). Twenty-five of the single-implant restorations were cement retained, while all multiple-unit restorations were screw retained.

The overall findings from the yearly follow-up examinations indicated minor marginal bone loss around 7 implants. The majority of the patients maintained excellent or fair oral hygiene. For 85% of the overdenture patients, the denture fit was rated as excellent or fair. The need for postdelivery maintenance/adjustment was obvious for a large number of the implant-supported overdentures. Twenty-four percent of the overdentures needed a reline during the observation period, and the majority of the patients (68%) with removable implant prostheses requested adjustment of the denture base. More than half (52%) of the retentive clips had to be adjusted because of impaired retention. There was a high incidence of technical complications for the implant overdentures, and more than 40% required replacement of retentive clips (Table 6).

Table 5	Types of Prostheses
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Туре	No.
Single-tooth restoration	64
Multi-unit fixed restoration	7
Overdenture	33
Total	104

Discussion

The majority of dental schools in North America have included implant education in their undergraduate training programs.7-9 According to surveys on predoctoral implant education, the number of US dental schools allowing students to restore implants clinically increased from 36% in 1995 to 88% in 2002.7 However, there is sparse information in the literature about the clinical outcome of implant treatments performed by undergraduate students.^{13,14} In the present study, the cumulative implant survival rate was 93%, which is comparable with findings in a previous study reporting on clinical outcomes of treatments with Brånemark implants performed in a university training program.¹³ However, in that study there was no information about implant type and surface texture. Another study reported a 95% survival rate over 6 years for implants placed in an elective program.¹¹ In the present study, there was an equal distribution of machinedsurface and TiUnite-surface implants among those that failed, indicating that surface texture did not play a significant role in the outcome. Further, all but 1 of the failing implants were placed in the mandible, and 7 of the 10 implants were 13 mm or longer. The implants were placed by experienced oral and maxillofacial surgeons using a surgical guide and following the traditional 2-stage surgical protocol with an intermediate healing period.

Although findings in several studies demonstrate a high success rate for implants placed in the posterior mandible, poor bone quality and large occlusal forces are factors that could play an important role in the outcome.¹⁵ In the present study, 6 of the failing implants were placed in the premolar/molar area of the mandible. Unfortunately, there were no chart records made at the time of implant surgery regarding the assessed bone quality or initial implant stability. However, 3 of the patients lost 2 implants each, indicating that there might be systemic factors involved, although there was no evidence in the patients' medical histories of contraindication to implant therapy. Since the treatments were performed as part of the undergraduate program, there were limited data available on each patient for evaluation of the failures.

Table 6 No. and Type of Technical Complications (n = 104)

Туре	No.	
Remaking of overdenture	4 (12%)	
Placement of new retentive clips	14 (42%)	
Loose prosthetic screw	10 (7%)	
Loose abutment screw	16 (11%)	
Fractured abutment screw	3 (2%)	

It is well known that implant overdentures require a substantial amount of maintenance, especially during the first year of service. In the present study, the need for postinsertion maintenance among the overdenture patients was also high, and retention clip activation was the most common complication (Table 6). More than half of the dentures needed adjustments, which is somewhat lower than the findings in previous studies of implant overdentures.^{16,17} In a study evaluating need for maintenance among 3 different attachment systems,¹⁶ the vast majority of the retention clips needed activation during the first year, while another study reported a frequency of 21 clip activations in 11 patients with implant overdentures over an observation period of 5 years.² In the present study, 42% of the retention clips fractured and had to be replaced during the observation period (Table 4). Reports from previous studies show clip fracture rates ranging from 16% to 62%, indicating that factors such as denture fit, occlusal forces, and type and number of clips should be included in such an evaluation.^{16,18} The fairly high frequency of fractured clips may also be explained by the fact that less-experienced students were using an inappropriate technique and/or instruments during the activation procedure. This could damage the clip, resulting in fatigue problems and eventually fractures in the metal. Further, the clips had all been supplied by Nobel Biocare and were designed with a sharp angle between the base and retentive flanges, making them more susceptible to fatigue fractures.

The need for maintenance also includes adjustment of the denture base as a result of continuing bone resorption. Almost 25% of the overdentures were relined because of impaired stability and fit, which is in accordance with findings in previous studies on implant overdentures.^{16,17}

All patients agreed to be included in a continuing care program and were scheduled for a yearly recall examination. The examination for the overdenture patients included removal of the bar for ultrasonic cleaning if necessary. The number of loose abutments and prosthetic screws may be explained by the fact that the torque control device was not routinely used when the bars were remounted after cleaning, resulting in an incorrect screw preload.

There were no complications related to the singletooth restorations that required refabrication of the crown. The majority of the crowns were screw retained, and cemented restorations were chosen only if there was a problem with the implant inclination. Wennstrom et al¹⁹ reported on 4 incidents of abutment screw loosening in 40 cemented single-tooth restorations after 5 years. In another retrospective study of 259 single-unit restorations, 8 crowns had to be remade as a result of prosthetic complications.²⁰ The patients maintained good oral hygiene, and increased marginal bone loss was observed for only 7 of the 166 implants (4%) and did not exceed 2 threads (1.2 mm) for any of those implants. In a study in which 71 IMZ implants were restored by predoctoral students, inflammation was observed around 70% of the implants, and 13% showed marginal bone loss exceeding 2 mm.¹⁴

Conclusion

The clinical outcomes of implant treatments performed by undergraduate students in the implant elective program at Dalhousie University are similar to those reported by experienced clinicians/research teams. Although the implant surgeries were performed by experienced oral and maxillofacial surgeons or periodontists, students had the main responsibility for planning the treatment and performing the prosthodontic procedures. The results also suggest that implant dentistry could be implemented as part of the curriculum in the undergraduate programs of dental schools.

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