Three-Year Clinical Outcomes of Implant Treatments Provided at a Predoctoral Implant Program

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Purpose: The aim of this study was to evaluate the clinical outcomes from a predoctoral implant clinic over 3 years. ***Materials and Methods:*** All patients who received implant-retained mandibular overdentures (IODs) or a single-tooth implant (STI) restoration in the Predoctoral Implant Program at the University of Illinois-Chicago College of Dentistry between 2006 and 2009 were included in this study. A two-stage surgical placement and healing protocol was followed by oral surgery, periodontic, and prosthodontic specialty clinics. The following potential prognostic information was collected: patient age and sex; implant diameter, length, and sites; and complications related to the treatment. Life-table and Kaplan-Meier survival analyses were performed for both IOD and STI patient groups. ***Results:*** A total of 371 implants were placed in 243 patients. There were 164 implants placed in 82 patients in the IOD group and 207 implants placed in 161 patients in the STI group. Two implants failed in the IOD group and 2 implants failed in the STI group. The cumulative survival rates for the implants in both the IOD and STI groups were 99%. Kaplan-Meier survival analysis showed no significant differences between the two groups. The most common complication observed in the IOD group was damage to the attachment inserts, and for the STI group, it was repair or remaking of the definitive prosthesis. ***Conclusion:*** As demonstrated by the 3-year clinical outcomes, a predoctoral implant program can provide predictable patient-centered therapy with few complications. Patient therapy, guided by thoughtful diagnosis and driven by restorative outcome, can lead to favorable results. *Int J Prosthodont 2011;24:71–76.*

With increased patient awareness and expectations,[1] dental graduates must have the ability to recognize the indication for implants and provide therapy at the appropriate level. Dental implant therapy has become a predictable and viable option for partially and completely edentulous patients,[2] and access to implant options for these patient populations will continue to grow in the future.[3] Advantages include conservation of the adjacent tooth structure, longevity with high success rates, and preservation of the alveolar bone.[4] A two-implant mandibular overdenture has been suggested as the first choice option for edentulous patients.[5] Implant-retained mandibular overdentures have shown positive long-term results with improved function and patient satisfaction,[5,6] as well as improved nutritional intake and health-related quality of life.[7–9] The need to thoughtfully incorporate implant therapy into predoctoral dental education is a current reality that must be addressed.

Diverse learning experiences nationwide lead to diverse abilities to recognize and integrate dental implants in treatment planning and therapy. Student learning regarding the application of implants has been integrated into predoctoral dental curricula at various levels.[10–13] Since the 1990s, many institutions have introduced implants to predoctoral students with experiences ranging from laboratory courses to implant placement.[10] Some institutions require these courses, whereas others offer elective programs.[12,13]

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In contrast, 16% of dental schools in the United States do not offer a predoctoral implant curriculum.[10,11] Because a standardized protocol for learning the practical aspects of patient treatment with implants has not existed in accreditation standards,[14] dental graduates in general have not been prepared in a systematic way to offer implant therapy to their patients in a predictable manner.

In response to a recognized need for the best practices for patient care and clinical learning, the Comprehensive Dental Implant Center was established at the University of Illinois-Chicago College of Dentistry in 2000. In 2005, the program began providing therapy for completely edentulous patients with two mandibular implants and an implant-retained overdenture (IOD). During the 2006–2007 academic year, the program expanded to include patient care with single-tooth implant (STI) restorations. Traditionally, implant dentistry has been taught in dental schools as a third- or fourth-year course in the form of lectures, laboratory components, and then clinical experience.[10–13] As part of the Predoctoral Implant Program, the responsibilities of each student included: reviewing the patient's medical history, performing a comprehensive clinical examination, identifying diagnostic criteria for implant care, performing diagnostic wax-ups, fabricating radiographic and surgical templates, assisting in surgery, and providing the definitive restoration and maintenance. All students were required to pass a comprehensive didactic and laboratory hands-on implant course during the second year of their dental curriculum prior to seeing implant patients.

The aim of this paper was to describe the 3-year clinical results from a retrospective study of the Predoctoral Implant Program at University of Illinois-Chicago College of Dentistry for STI and IOD patients from the 2006 to 2009 academic years.

Materials and Methods

Patient Selection

This study was approved by the University of Illinois-Chicago Institutional Review Board (research protocol no. 2008-1003). All patients treated in the Predoctoral Implant Program from April 2006 through April 2009 were identified using electronic patient records (axiUm, Exan). Patient selection criteria were based partially on the Prosthodontic Diagnostic Index[15,16] for partially and completely edentulous patients. Patient inclusion criteria for the proposed implant site were: at least 7 mm of bone width, at least 10 mm of bone height in the maxilla or 12 mm or more in the mandible, and at least 4 mm faciolingual width of keratinized tissue. In addition, patients had to be American Society of Anesthesiologist physical status classification I, II, or III.[17] Exclusion criteria included implant sites on central incisors because of the potential difficulty in restoring these teeth at the predoctoral level; second or third molars were excluded because of potential anatomical restrictions. Also, areas needing any type of bone or soft tissue grafting were not selected for predoctoral implant care.

After predoctoral faculty approval, patients were assigned to one of three postgraduate clinics available for implant placement: oral and maxillofacial surgery, periodontics, or prosthodontics. The patient distribution to the postgraduate clinics was 40%, 40%, and 20%, respectively.

Patient Therapy

IOD treatment included placement of two endosseous implants in the mandibular canine region followed by two abutments for resilient attachments (Locator, Zest Anchors). After the implants were integrated, metal housings were added to the existing denture for the attachments. All patients received Locator abutments 2 to 3 weeks after the stage-two surgery.

For STI care, one or two missing teeth were generally accepted. Implant placement was mostly followed by placement of a prefabricated abutment and a metal-ceramic crown. The majority of the prosthetic abutments used were the Snappy Abutment System (Nobel Biocare), where an abutment-level impression was made with a snap-on coping. In areas where implant placement necessitated modification over abutment design, an implant-level impression was made and the Esthetic Abutment System (Nobel Biocare) was used. Esthetic abutments were prefabricated and modified for proper angulation or margin placement. A 15-degree angulated Esthetic abutment was used occasionally. A two-stage surgical approach was used for all implant placements. The stage-two surgery to place the healing abutments occurred 4 months after initial implant placement. All restorations were cement-retained, and complete seating of the restoration was verified with a periapical radiograph.

Patient Assessment

Recalls were scheduled at 1 week, 1 month, 3 months, 6 months, 1 year, and annually thereafter for IOD patients and 1 month, 6 months, 1 year, and annually thereafter for STI patients. At the recall appointment, an intraoral examination was performed and a periapical radiograph was taken to evaluate the interproximal

Table 1 Patient Demographics and Procedures Performed by Academic Year

	IOD	STI	Total
Age (y)			
Mean	63.8	51.1	57.45
Range	43–90	20–79	20–79
Sex (n)			
Female	28 (34.1%)	93 (57.8%)	121 (49.8%)
Male	54 (65.9%)	68 (42.2%)	122 (50.2%)
Total	82 (33.7%)	161 (66.3%)	243 (100.0%)
Placement time (by patient)			
2006	2 (2.4%)	4 (2.5%)	6 (2.5%)
2007	38 (46.3%)	47 (29.2%)	85 (35.0%)
2008	32 (39.0%)	75 (46.6%)	107 (44.0%)
2009	10 (12.2%)	35 (21.7%)	45 (18.5%)
Total	82 (33.7%)	161 (66.3%)	243 (100.0%)

IOD = implant-retained overdenture; STI = single-tooth implant.

bone height or pathoses. For IOD patients, the retention of the overdenture attachments was verified through clinical examination. The pink Locator inserts were initially placed at the time of prosthesis insertion, which provided 3 lbs of retention. The inserts were chosen according to the patient's ability to remove the overdenture or the patient's desire for increased or decreased retention. At the recall appointments, patients demonstrated their ability to insert and remove the prosthesis. The attachments were inspected for any damage or collection of plaque or food debris and replaced as needed. The stability of the overdenture was verified by placing anteroposterior force over the abutments and the posterior ridge. Occlusion was evaluated by using a double-sided articulating film (AccuFilm II, Parkell). STI restorations were evaluated by verifying complete seating with a periapical radiograph, and the retention of the crowns were presumed stable. Occlusion was evaluated using a double-sided articulating film (AccuFilm II) and metal foil (Shim Stock, Almore International). Oral hygiene was assessed and oral hygiene instructions were reinforced.

The criteria for implant survival defined by Albrektsson et al[18] were modified for the implant failure criteria used in this study, which consisted of any implant that was removed due to clinically detectable mobility of the implant from lack of osseointegration, infection, inability to restore, or restorative complications. Surgical and prosthetic complications were recorded and addressed accordingly. Also, in this study, the collected data represented only the initial implant placement. Thus, when an implant failed and was replaced after bone grafting, it was still considered a failure during data analysis.

Statistical Analysis

Age and sex of the patients, implant information including diameter and length for STI and IOD patients and implant sites for STI patients, and surgical and restorative complications were entered into a Microsoft (Microsoft Access) database. Descriptive statistics were also used to analyze the results. Life-table analysis and Kaplan-Meier survival analysis ($\alpha = .05$) were completed for both groups regarding the total number of implants using statistical software (SPSS version 17.0, IBM). Differences between IOD and STI groups were assessed.

Results

From April 2006 to April 2009, 243 patients (82 IOD, 161 STI) were treated for implant therapy in the Predoctoral Implant Program. Demographics for all implant patients and the number of patients who received implant placement each year are presented in Table 1.

The total number of implants placed is presented in Fig 1. For IOD patients, 164 implants were placed. The Osseospeed (Astra Tech) implant was the most commonly used implant for patients with overdentures. A total of 207 implants were placed for the STI group. The majority of implants used for this group were Replace Straight Groovy (Nobel Biocare). The implant sites for STIs are shown in Table 2. The most prevalent areas for STIs were the mandibular molar region (37.6%) and the maxillary premolar region (36.2%).

For the total number of implants placed, a cumulative survival rate of 99% was observed for both IOD and STI groups in the 3-year period (Table 3).

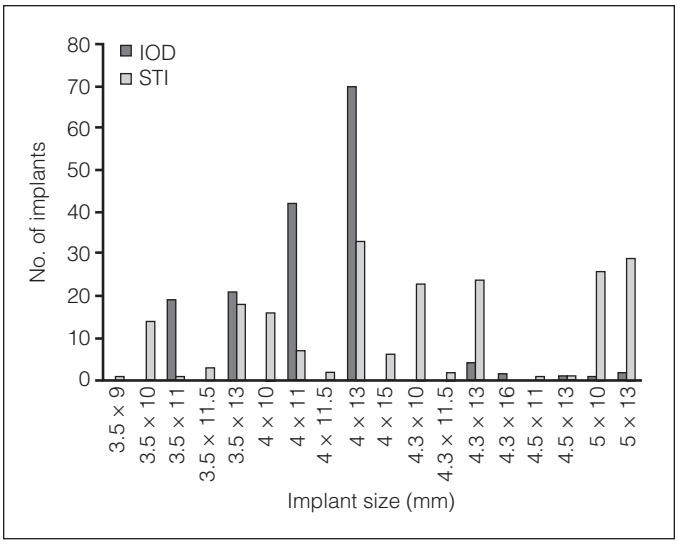

Fig 1 Distribution of implants by size and procedure.

Table 2 Implant Site for STI Restorations

Site	N
Maxilla	106 (51.4%)
Molar	17 (8.1%)
Premolar	76 (36.2%)
Canine	3 (1.4%)
Lateral incisor	10 (4.8%)
Mandible	101 (48.6%)
Molar	79 (37.6%)
Premolar	22 (10.5%)
Canine	0 (0.0%)
Lateral incisor	0 (0.0%)
Total	207 (100.0%)

STI = single-tooth implant.

Table 3 Implant Life-Table Analysis for IOD and STI Groups

Observation period (mo)	No. of implants	No. of implants exposed to risk	No. of failed implants	Proportional survival rate (%)	Cumulative survival rate (%)
IOD					
< 6	207	168	2	99	99
6–11	127	106	0	100	99
12–17	85	64.5	0	100	99
18–23	44	26.5	0	100	99
24–29	9	4.5	0	100	99
STI					
< 6	164	139	2	99	99
6–11	112	107	0	100	99
12–17	101	85	0	100	99
18–23	68	42	0	100	99
24–29	16	10	0	100	99
30–35	4	3	0	100	99
36–41	2	1	0	100	99

IOD = implant-retained overdenture; STI = single-tooth implant.

A nonparametric Kaplan-Meier analysis revealed no statistically significant differences in the survival rates between the two treatments. The Kaplan-Meier plot showed a similar proportional survival rate, with implant failures occurring within the first 6 months (Fig 2). There were no significant differences in the proportional survivals between the two groups. Of the 164 implants in the IOD group, 2 implants (4 × 11 mm) failed, 1 each in two patients. In the STI group, there were 2 failures from 207 implants placed (1.0% failure rate). The implants that failed were 4 × 11 mm and 3.5 × 13 mm.

Complications from the IOD and STI groups are described in Table 4. The most common complication observed for the IOD group was damage to the attachment inserts (12.2%). The most common complication for the STI group was repair or remaking of the definitive prosthesis (6.9%).

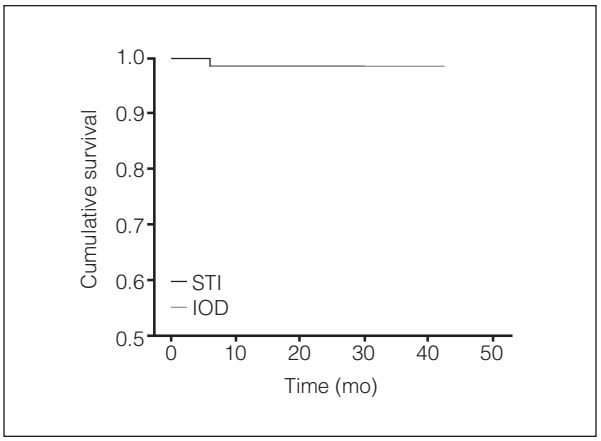

Fig 2 Kaplan-Meier survival function for implants placed.

Table 4 Number and Type of Complications

Complication Type	IOD (n=82)	STI (n = 161)
Surgical		
Soft tissue inflammation/ dehiscence/overgrowth	2 (2.4%)	11 (6.8%)
Postoperative pain	2 (2.4%)	5 (3.1%)
Bone loss	1 (1.2%)	4 (2.5%)
Implant failure	2 (2.4%)	2 (1.2%)
Prosthetic		
Damaged prosthetic parts	10 (12.2%)	—
Repair/remaking of definitive prosthesis	5 (6.1%)	12 (6.9%)
Replacement of prosthetic components	4 (4.9%)	—
Faulty occlusion	1 (1.2%)	1 (0.6%)
Food impaction	—	2 (1.2%)
Recementation	—	3 (1.9%)
Total frequency	27 (33.0%)	40 (24.8%)

IOD = implant-retained overdenture; STI = single-tooth implant.

Discussion

The cumulative implant survival rate of 99% for the Predoctoral Implant Program at the University of Illinois-Chicago is comparable to other studies.[19,20] The high implant survival rate from 371 implants for the program can be attributed to the diagnostic and assessment protocols, careful patient selection process, and philosophy for restoration-driven therapy, all of which are important in a predoctoral implant program. For this program, careful patient selection resulted in the referral of patients with indications for more complex therapy, such as grafting, to more advanced programs.

Implant failures were nevertheless observed. In the IOD group, one implant failed due to infection and the other failed from lack of osseointegration. Both failures occurred prior to delivering the definitive prostheses. In the STI group, one implant was removed due to loss of primary stability, and the other was removed because a prosthetic screw fractured inside the implant. To date, none of the implants have failed after restoration. Maalhagh-Fard and Nimmo[19] reported a 6.3% failure rate for 159 implants over the course of 11 years in their predoctoral implant program, whereas Kronstrom et al[20] reported a survival rate of 93% for 166 implants in 95 patients.

The most frequent complication and maintenance issue in the IOD group was damage to the resilient inserts that engage the Locator abutments. This may have occurred because of improper angulation of the two implants, failure of the insert components, or the patient biting down on the denture to engage the abutments. Chaffee et al[21] found that the most common IOD prosthetic complications were denture base adjustments and adjustments to the ball housing attachment mechanism. Goodacre et al[22] also identified loosening of the overdenture retentive mechanism or adjustment as the most common mechanical complication.

In the STI group, the most common complication was repair or remaking of the definitive prostheses because of a loss of interproximal contact from overpolishing. Other common complications noted for this group were soft tissue overgrowth, inflammation, or dehiscence. This was mostly due to the loss of the healing abutment after stage-two surgery. The complications listed in this study were similar in trend and frequency to those reported in the literature.[21–23] Berglundh et al[23] reported that technical complications were more common than peri-implant tissue complications and that technical complications were more common for IODs than fixed implant restorations. While some complications were not caused by the patient, others may have been prevented through proper patient education, oral hygiene, and a consistent recall regimen.

All of the dental implants in the Predoctoral Implant Program were placed by residents in the advanced graduate programs of oral and maxillofacial surgery,

periodontics, and prosthodontics. Residency programs have shown great success in their ability to provide implant therapy. Starr and Maksoud[24] reported an implant survival rate of 96.6% in a 7-year period at an advanced general dentistry residency program, whereas Melo et al[25] showed 91% survival rate from 175 implants placed in an oral surgery program, suggesting that residency programs may have predictable results. By participating in the University of Illinois-Chicago Predoctoral Implant Program, residents gained valuable teaching experience with predoctoral students, while receiving additional implant surgical training. Also, by working with other departments, this allowed for a multidisciplinary approach, stronger interdisciplinary communication, and supportive care for the implant patients.

Conclusions

Patient implant therapy at the predoctoral level that is guided by thoughtful diagnosis and driven by a restorative outcome can lead to favorable short-term results. An implant survival rate of 99% with few complications was observed for both IOD and STI groups. The implant survival rate did not differ between both groups, yet future studies will report on ongoing provider- and patient-centered outcomes.

Disclosure

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