Retrospective Analysis of Implant Overdenture Treatment in the Advanced Prosthodontic Clinic at the University of Illinois at Chicago

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The aim of the present retrospective study was to evaluate the clinical outcomes of implant-supported overdenture treatment provided by prosthodontic specialty residents. Twenty-three patients with 25 implant-supported overdentures (IODs) participated in the study. Seventy-four implants were placed by periodontic, prosthodontics, or oral and maxillofacial surgery students. All prostheses were fabricated in the advanced prosthodontics clinic at University of Illinois at Chicago. The condition of the peri-implant soft tissue, implants, and prostheses were evaluated. Complications and any maintenance were documented. Patients completed an oral health impact profile-14 and semantic differential scale questionnaires. Statistical analyses were performed using SPSS statistical software. Twenty mandibular and 5 maxillary IODs were evaluated. Ninety-seven percent of the attachments were locators (Zest Anchors) and 3% ball attachments. None of the implants had lost osseointegration, but 14 implants (19%) had developed marginal bone loss in one-third of the implant length or more. Fourteen (19%) implants had developed dehiscence, which ranged from 1 to 4 mm. A variation in the width of the keratinized tissue, gingival, plaque, and calculus index was observed. There was a statistically significant relationship between the presence of plaque and the bleeding on probing on the buccal aspect of implants ($P = .012$). The incidence of dehiscence was significantly higher on the midfacial when the keratinized tissue was less than 2 mm ($P < .0001$). The majority of the complications were prosthetic in nature, such as broken denture teeth (74%) and worn or loose matrices (35%). Debris was observed in 19% of the locator abutments, and 36% of the overdentures were not stable in application of anterior force. Patients were compliant with oral hygiene protocols and their chewing ability was high (mean = 8.0). The overall experience was pleasant (mean = 7.5); the treatment provided good esthetics (mean = 8.3) and great satisfaction (mean = 8.5). From an educational and clinical perspective, IOD therapy has been documented to be a predictable and successful treatment option. Patients should be informed of the required maintenance and the possible complications related to IOD therapy.

Key Words: implant, overdenture, maxillary, mandibular, OHIP, clinical outcomes, locators, quality of life, advanced prosthodontics clinic

INTRODUCTION

The World Health Organization classifies complete edentulism as a physical disability.[1] Edentulism is a major public health problem, and demographics reveal an increase in the edentulous population as a result of an increase in life expectancy.[2] Implant-supported overdenture (IOD) has been established as a basic treatment option for mandibular edentulism.[2] Based on randomized and nonrandomized clinical trials, a mandibular overdenture supported by 2 implants is a treatment option superior to conventional denture therapy.[3–7] In comparison with the well-documented mandibular IODs, there are few studies to support maxillary IODs.[8] However, implants have been utilized in the maxilla to enhance support, retention, and stability of the denture, as well as to reduce overall patient dissatisfaction with full palatal coverage prostheses.

It is important to evaluate treatment outcomes in teaching institutions, as the resulting data can be extrapolated to both education and clinical practices. Many studies of IODs have been completed at the predoctoral level.[9–15] However, strict clinical criteria are used to select IOD patients for predoctoral education. On the other hand, postdoctoral clinics treat a variety of patients with complex needs. The outcomes of those patient treatments are more representative of the general

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population and should be examined. Few studies have described IOD therapy in postdoctoral clinics without discussing both implant and prosthetic outcomes.[16]

Patient perception is a critical component of treatment success.[17,18] Most studies suggest that edentulous patients who choose mandibular IODs have significantly greater satisfaction than those who choose new conventional dentures, despite the relatively high cost.[3,7,19–21] Heydecke et al[22] evaluated the quality of life for patients that received conventional mandibular dentures and IODs. They concluded that the overall oral health-related quality of life for IOD patients was improved.

The clinical outcome of IOD therapy is essential for both dentists and patients. Critical assessment of overdenture prosthesis, the supporting implants, and soft tissue provides significant information regarding the ability of these treatment modalities to restore masticatory efficiency, improve esthetics and phonetics, and enhance oral health. The establishment of specific criteria for the evaluation of the overdenture prosthesis is a prerequisite for an objective assessment. The criteria for objective assessment should include treatment outcomes, maintenance, and any complications related to surgery, implants, or prostheses. The main purpose of this retrospective study was to evaluate the clinical outcomes of IODs fabricated by residents in the advanced prosthodontic program at the University of Illinois at Chicago (UIC) College of Dentistry. In addition, patient satisfaction, quality of life, and perception of the treatment were investigated.

Materials and Methods

A retrospective analysis of patients that received IOD treatment in the UIC advanced prosthodontic clinic was organized (Research Protocol 2008-0866). All patients who received at least 1 arch IOD treatment from 2004 to 2012 were identified (61 patients) through the electronic patient record (axiUm, Coquitlam, BC, Canada). Forty-three patients (52 IOD prostheses) were contacted via telephone and requested to participate in the study. The rest of the patients could not be reached or did not respond.

The study was organized into 3 parts. Initially, the research group reviewed the patients' electronic records, comprising of information regarding the patients' demographics, medical, and dental history. The type of IOD (ie, with or without framework, interim or final, type of attachment) and the status of the opposing arch were identified. All surgical, implant, and prosthetic complications were recorded. The second portion of the study was assessment of patient satisfaction and quality of life via questionnaires. The last part of the study incorporated the intraoral clinical evaluation.

Medical history and patient satisfaction

The medical history was reviewed, with an emphasis on diabetes, smoking, radiation, and bisphosphonate treatment, which are common conditions with direct correlation to implant survival.[23–26] Patients completed a 14-item Oral Health Impact Profile (OHIP-14) and a Semantic Differential scale questionnaire for assessment of their oral health-related quality of life and satisfaction. The patients were asked to record their responses on a 5-point Likert scale (0 = never, 1 = hardly ever, 2 = occasionally, 3 = fairly often, 4 = very often) for the OHIP-14 questionnaire. Patient satisfaction on the IOD treatment was recorded regarding the treatment cost, the treatment duration, esthetics, chewing ability, pain experience, and overall satisfaction using a semantic differential scale ranging from 1 (negative) to 10 (positive). Patients were asked to describe their oral hygiene habits for both the implants and the prosthesis.

Evaluation of the prostheses

A standardized evaluation criteria form was developed, and clinical examination was performed to evaluate the conditions of the implants, peri-implant tissues, and overdenture prostheses.[27,28] Standardized procedures and calibrated examiners were used to clinically assess the prostheses, implants, and peri-implant tissue. The agreement between the examiners was assessed with the κ test. Intraoral and extraoral evaluation of the IOD was performed to determine whether esthetics and function were satisfactory, as well as whether any additional treatment was required. The fit and stability of the IOD was evaluated utilizing silicone indicator paste (Fit Checker, GC America, Alsip, Ill) on the intaglio surface of the prosthesis, and by asking the patient to gently bring the teeth in contact. The thickness of the material was recorded with the use of a 15-UNC metal Probe (Hu Friedy, Chicago, Ill).

The stability of the IOD was evaluated by the application of force by the examiner. This was applied unilaterally and bilaterally on the posterior extensions, as well as on the anterior teeth. Additionally, patients were asked to open their mouth and bring their tongue up to the lip. Any prosthesis dislodgement was noted. The implant abutments were examined, and any loose or missing parts were recorded. The retentive attachments were also checked for distortion or debris. If the IOD had a framework, it was examined for possible fractures. The overdenture itself was also examined extraorally for missing, fractured, or worn teeth. The intaglio surface of the overdenture was evaluated for the application of reline materials, and for missing or distorted parts related to the implant attachments.

Evaluation of implants and peri-implant tissue

Implants were assessed based on clinical and radiographic criteria.[29] The width of keratinized tissue on the facial and lingual aspect of the implant was measured.[30] The calculus, plaque, and gingival indices were determined using a plastic probe 12-UNC (Hu Friedy) that was placed slightly below the gingival margin.[31–34] Any pathoses or dehiscence that was identified based on the radiographic or clinical exam were reported/recorded and categorized.

Statistical analyses

Descriptive statistics such as percentage, range, mean, and standard deviation were used to analyze the gathered data. The potential relationships between gingival index (bleeding vs no bleeding) and plaque index (presence vs absence), gingival index (bleeding vs no bleeding) and keratinized tissue (0–2 vs $>$2 mm), and dehiscence (presence/absence) and keratinized tissue (0–2 vs $>$2 mm) were examined using the χ^2 test. All statistical analyses were performed with a software program (SPSS v 20.0, SPSS, Chicago, Ill). For all analyses, α was equal to 0.05.

TABLE 1

Patient demographic information, including age, sex, ethnicity, and medical history

Patient Demographics	Patients with Implant-Supported Overdentures
Mean age, years (range)	74 (59–89)
Male, n (%)	12 (52%)
Female, n (%)	11 (48%)
Ethnicity	
Asian, n (%)	2 (9%)
African American, n (%)	6 (26%)
Caucasian, n (%)	14 (61%)
Hispanic, n (%)	1 (4%)
Medical history	
Smoker, n (%)	1 (4%)
Diabetic, n (%)	4 (17%)
Radiation therapy, n (%)	5 (22%)
Bisphosphonate, n (%)	IV: 1 (4%) Oral: 3 (13%)

RESULTS

Medical history and patient satisfaction

Twenty-three patients volunteered to participate in the study, and written consent was obtained. The demographics of the patient population are presented in Table 1. Based on the patients' medical history, 3 patients (13%) were using oral bisphosphonate medication and 1 patient (4%) initiated intravenous bisphoshonate a year before the initiation of the study but after implant placement. Five (22%) patients had received radiation therapy, but only one of them received it in the head and neck region. The amount of radiation was not reported for this individual. All implants that were placed for IODs had successfully osseointegrated, and none of the implants had to be removed within the observation period (6 months to 8 years).

TABLE 2

Mean scores of Oral Health Impact Profile-14 of the studied population.

Questions	Mean ± SD
1) Have you had trouble pronouncing any words because of your implant restorations(s)?	0.5 ± 0.8
2) Have you felt that your sense of taste has worsened because of your implant restoration(s)?	0.7 ± 1.3
3) Have you had painful aching in your mouth?	0.7 ± 1.0
4) Have you found it uncomfortable to eat any foods because of your implant restoration(s)?	0 ± 0.6
5) Have you been self-conscious because of your implant restoration(s)?	1.1 ± 1.2
6) Have you felt tense because of problems with your implant restoration(s)?	0.7 ± 0.9
7) Has your diet been unsatisfactory because of your implant restoration(s)?	0.6 ± 1.1
8) Have you had to interrupt meals because of your implant restoration(s)?	0.8 ± 1.0
9) Have you found it difficult to relax because of your implant restoration(s)?	0.4 ± 0.9
10) Have you been embarrassed because of your implant restoration(s)?	0.3 ± 0.7
11) Have you been a bit irritable with other people because of your implant restoration(s)?	0 ± 0.2
12) Have you had difficulty doing your usual jobs because of your implant restoration(s)?	0.2 ± 0.5
13) Have you felt that life in general was less satisfying because of your implant restoration(s)?	0.4 ± 0.9
14) Have you been totally unable to function because of your implant restoration(s)?	0 ± 0

TABLE 3

Mean score of semantic differential scales of the studied population

My Overdenture Treatment Was. . .(1–10)	Mean ± SD
1) Expensive—Inexpensive	5.8 ± 2.6
2) Time-consuming—Quick	5.3 ± 2.2
3) Painful—Pain Free	6.5 ± 2.8
4) Poor Aesthetics—Good Aesthetics	8.3 ± 2.3
5) Poor Chewing Ability—Good Chewing Ability	8.0 ± 2.1
6) Unpleasant—Pleasant	7.5 ± 2.2
7) Very Dissatisfied—Very Satisfied	8.5 ± 1.9

The results of the OHIP-14 and the semantic differential scale surveys are described in Tables 2 and 3. The mean scores of each OHIP-14 category were between 0 (never) to 1 (hardly ever), suggesting low impaired functions from the IODs. The semantic differential scales results revealed high patient satisfaction with the IOD treatment (mean = 8.5). As reported by the patients, the overall experience was pleasant (mean = 7.5), and the treatment provided good esthetics (mean = 8.3) and chewing ability (mean = 8). The patient perception of pain related to the treatment was 6.5 with a large standard deviation (SD = 2.8).

Evaluation of the prostheses

The majority of the IODs evaluated were in the mandibular arch (20 prostheses), and 5 were maxillary overdentures. The number of the overdenture prosthesis in relation to the months of function is described in Table 4. The attachments for all those prostheses were resilient attachments (Locator, Zest Anchors, Escondido, Calif) with the exception for two (ball attachments). Most of the IOD were opposing a conventional complete denture (17 patients, 68%). Inter-rater agreement demonstrated a κ value of 0.849 ($P < .05$). The κ value implied almost perfect agreement.

TABLE 4

Distribution of supporting implants and overlying prosthesis relative to their respective functional duration*

Functional Duration (months)	Implants (n)	Prosthesis (n)
0–12	12	4
13–24	0	4
25–36	10	6
37–48	16	5
49–60	10	6
61–72	17	0
73–84	0	0
85–96	4	0
Unknown	5	0
Total	74	25

*Start time for the implant functional duration is the time of placement of healing abutment (second stage) or overdenture attachment. Prosthesis functional duration starts at the time of the delivery of the prosthesis.

Table 5
Implant information

	n (%)
Plaque index	
Mesial	
0	37 (50)
1	15 (20)
2	16 (22)
3	6 (8)
Distal	
0	36 (49)
1	15 (20)
2	19 (26)
3	4 (5)
Buccal	
0	35 (47)
1	19 (26)
2	14 (19)
3	6 (8)
Lingual	
0	40 (54)
1	15 (20)
2	14 (19)
3	5 (7)
Gingival index	
Mesial	
0	58 (78)
1	9 (12)
2	5 (7)
3	2 (3)
Distal	
0	55 (74)
1	12 (16)
2	5 (7)
3	2 (3)
Buccal	
0	57 (77)
1	11 (15)
2	4 (5)
3	2 (3)
Lingual	
0	56 (76)
1	12 (16)
2	4 (5)
3	2 (3)
Keratinized gingiva (mm)	
Facial	
0	16 (22)
1	8 (11)
2	8 (11)
3	19 (25)
4	10 (14)
5	9 (12)
>5	4 (5)
Lingual	
0	29 (39)
1	14 (19)
2	10 (13)
3	11 (15)
4	0 (0)
5	2 (3)
>5	8 (11)
Calculus index	
0	61 (82)
1	7 (10)
2	4 (5)
3	2 (3)
Dehiscence (mm)	
Facial	
0	60 (81)
1	9 (12)
2	2 (3)
3	1 (1)
4	2 (3)
Lingual	
0	65 (88)
1	6 (8)
2	1 (1)
3	1 (1)
4	1 (1)

Intraoral evaluation of the prosthesis revealed that the distal extension of intaglio surface of 4 IODs lacked close contact bilaterally. There was no significant movement in the prosthesis when forces were applied by the examiner in the posterior teeth (unilateral and bilateral forces) upon opening wide or protruding the tongue. Nine of 25 IODs (36%) were considered unstable in the application of forces on the anterior teeth. Eight of these 9 IODs were mandibular overdentures. Only 2 of the overdentures did not provide adequate esthetics and phonetics based on the examiner's evaluation. The examination of the implant abutments showed no missing abutments, whereas one abutment was distorted and another was loose. The main observation regarding the abutments was the debris (food/calculus) accumulated inside the Locators (n = 14, 19%). Eight of the prostheses had distorted or missing matrices, and 2 had broken acrylic teeth or cracks in the denture base. There was a significant amount of posterior teeth wear (n = 8) compared with only 2 overdentures with anterior teeth wear. Seven of the prostheses had been relined, and only 1 patient was using denture adhesive.

Evaluation of implants and peri-implant tissue

The majority of the mandibular IODs were supported by 2 implants (70%); the remaining prostheses were supported by 4 (20%) or 5 implants (10%). In the mandible, the 48 implants had been placed intraforaminally and 4 posterior to the mental foramen. Maxillary IODs were supported by 4–6 implants. The total number of implants that were evaluated was 74. With the exception of 5 existing implants, all implants were placed by periodontics, prosthodontics, or oral and maxillofacial surgery residents. Sixty-six of the implants were Astra Tech (Densply, Mölndal, Sweden), 4 implants were Biomet 3I (Palm Springs, Fla), 2 implants were Nobel Replace (Nobel Biocare, Gothenburg, Sweden), and 2 implants fixtures could not be identified. The majority of the implants were 11–13 mm long and 3.5–4 mm wide. The number of implants in relation to the functional duration of the implants is reported in Table 4.

Soft tissue evaluation revealed 1 patient with a traumatic ulcer, 1 patient with epulis fissuratum, 2 patients with denture stomatitis, and 4 patients with flabby ridge related to the overdenture. The plaque, calculus, and gingival indices are described in Table 5. There was a statistically significant

Table 6

Gingival index vs plaque index†

	Bleeding			
	No		Yes	
Plaque	Midfacial	Midlingual	Midfacial	Midlingual
No	32 (43.2%)*	34 (45.9%)	3 (4.1%)*	6 (8.1%)
Yes	25 (33.8%)*	22 (29.7%)	14 (18.9%)*	12 (16.2%)

†The presence (yes) or absence (no) of bleeding and plaque observed midfacial and midlingual of all assessed implants. Percentages of total implants are also displayed.

*Statistical significance ($P < .05$).

Table 8

Dehiscence vs keratinized tissue†

	Presence of Dehiscence			
	No		Yes	
Keratinized Tissue	Midfacial	Midlingual	Midfacial	Midlingual
0–2 mm	19 (25.7%)*	44 (62.9%)	13 (17.6%)*	9 (12.9%)
> 2 mm	41 (55.4%)*	17 (24.3%)	1 (1.4%)*	0 (0.0%)

†The presence (yes) or absence (no) of dehiscence relative to the amount of keratinized tissue observed midfacial and midlingual of all assessed implants. Percentages of total implants are also displayed.

*Statistical significance ($P < .05$)

relationship between the presence of plaque and the bleeding on probing on the buccal aspect of implants ($P = .012$). No significant difference was observed for the lingual aspect of the implants ($P = .079$; Table 6). A variation in the width of the keratinized tissue was observed (Table 5). No statistically significant relationship was detected between the gingival index and amount of keratinized gingival for both the midfacial ($P = .112$) and midlingual ($P = .492$; Table 7). Fourteen (19%) of the implants developed dehiscence, which was measured on the midfacial and midlingual of the implant. The range of the dehiscence was from 1 to 4 mm (Table 5). There was a statistically significant relationship between the amount of keratinized tissue and the presence of dehiscence on the midfacial ($P < .0001$), but was not statistically significant for the midlingual ($P = .101$; Table 8). Bone loss around the implants was evaluated with periapical radiographs.[29,35] Fourteen of 74 implants (19%) developed bone loss that was equal to, or more than one-third of the implant length. Ten implants had bone loss and soft tissue dehiscence, 4 implants had bone loss without any dehiscence, and 4 implants were found with dehiscence without significant bone loss based on the periapical radiographs.

Prosthetic complications

Most of the complications that occurred since the initiation of the IOD treatment were prosthetic complications, and fewer were surgical/implant related complications (Table 9). Five of the 23 patients (22%) did not have any complications. The most significant prosthetic complication that was observed was a broken or loose denture tooth in the prosthesis or the opposing prosthesis (74%). The relation of the incidence of broken denture teeth with the time of functional use of the overdenture prosthesis is described in Table 10. This complication was repairable at the same appointment. The second most significant finding was related to the overdenture insert that was either worn out, distorted, or missing, or patients had difficulty placing or removing the prosthesis. None of the complications that were observed had caused complete failure of the prosthesis or the implants.

Table 7

Gingival index vs keratinized tissue*

	Bleeding			
	No		Yes	
Keratinized Tissue	Midfacial	Midlingual	Midfacial	Midlingual
0–2 mm	28 (37.8%)	41 (58.6%)	4 (5.4%)	12 (17.1%)
>2 mm	29 (39.2%)	15 (21.4%)	13 (17.6%)	2 (2.9%)

*The presence (yes) or absence (no) of gingival bleeding relative to the amount of keratinized tissue observed midfacial and midlingual of all assessed implants. Percentages of total implants are also displayed.

Discussion

This study evaluated 23 patients that received IOD treatment in the advanced prosthodontic clinic at the UIC for a period ranging from 6 months to 8 years. The variety and the complexity of the patients treated at the postgraduate level can provide information regarding treatment success, fulfillment of patient expectations, and maintenance in a wide range of patient populations. The results of the study support the overall IOD treatment strategy for patients. Furthermore, patients reported a high overall satisfaction with the outcomes of care, and improvement in their quality of life. The duration and the cost of treatment were scored with lower satisfaction but still above average. This study confirms the results of other studies regarding the patient perception of the mandibular IOD treatment and may imply the results for maxillary IOD. A

Table 9

Complications

Complication Type	n (%)
Surgical/implant	
Soft tissue inflammation/dehiscence/overgrowth	14 (19)
Postoperative pain	2 (9)
Bone loss	14 (19)
Perforation of inferior border of mandible	1 (4)
Prosthetic	
Replacement plastic insert (worn/lost insert, loose implant-supported overdentures)	8 (35)
Broken/loose teeth in over denture or opposing denture	17 (74)
Speech problem (patient)	1 (4)
Difficulty to completely sit the prosthesis	2 (9)
Difficulty to take out the prosthesis	3 (13)

TABLE 10

Incidence of denture tooth fracture relative to the functional duration of the prosthesis*

Functional Duration (months)	Incidence, n/N (%)
0–12	3/25 (12%)
13–24	4/21 (19%)
25–36	4/17 (23%)
37–48	4/11 (36%)
49–60	2/6 (33%)

*n, number of denture teeth fracture occurrences for all the prostheses (N) in function during the specified time period.

significant improvement in the patients' quality of life with mandibular IOD has been widely reported in the literature.[3,7,9,19–22] Raghoebar et al[5] reported higher patient satisfaction with IOD compared with new mandibular conventional dentures. In a 10-year follow-up study Van der Bilt et al[36] reported a large increase in the maximum bite force and masticatory performance of patients that transitioned from conventional dentures to overdentures. Other authors have provided evidence that mandibular IOD improved patients' comfort, ability to chew, and ability to speak.[4,6,7] Sadowsky[8] suggested that there are not enough data to strongly support the maxillary overdenture. Zembic and Wismeijer[37] reported that patients who encountered problems with their existing maxillary dentures showed improvement in oral health quality of life when they received maxillary overdentures.

All 74 implants in this case study maintained osseointegration and continued to successfully support the overdentures. Prosthetic, implant, and surgical complications were common. Certain complications (ie, broken denture teeth) were well documented in the patient records. Other complications, such as marginal bone loss, may have occurred on an ongoing basis; therefore, a specific date of occurrence cannot be associated with the complication. These complications were only noted on the day of evaluation, as the present study is a retrospective, cross-sectional study. Only 22% of the patients did not have any type of complication (their prosthesis were 1–4 years old). It is important to mention that the complications reported in this patient population were not detrimental to the survival of the implants or the prosthesis. Providing the needed maintenance allowed all 25 prostheses that were examined to be fully functional.

High survival rates for mandibular IODs have been reported in the literature.[10,38] There are few studies that have evaluated the survival rate of maxillary IODs and their supporting implants. Goodacre et al[39] suggested higher implant loss in maxillary IOD compared with mandibular IOD or maxillary fixed complete denture. The same authors in 2003 reported 19% implant loss in maxillary overdentures.[40] Bryant et al[41] concluded that implant-supported fixed and removable treatments had a high level of success for both the maxilla and mandible, with the exception of the maxillary overdenture. Laurito et al[42] suggested 86% success for maxillary overdenture and 95% success for mandibular overdenture. In the present study, the authors did not find any differences between implant survival rate of maxillary and mandibular IODs; however, this study included only 5 maxillary IODs, which were supported by 4–6 implants. Parel[43] suggested a higher risk in implant failure for the male population, and opposing natural dentition when they are restored with 4 maxillary implants supporting a fixed complete denture. The current study did not have sufficient evidence to support a similar trend for maxillary IODs against natural dentition or differences in sex.

The establishment of criteria for evaluation of the soft tissue supporting the implants is important. There is no consensus in the literature regarding the relation of the gingival index (GI), plaque index (PI), calculus index (CI), and the amount of keratinized gingiva to the success or failure of implants. Adell et al[31] and Lekholm et al[32] suggested that this traditional way of evaluating the periodontal tissue does not provide sufficient information regarding the peri-implant soft tissue. On the other hand, Lindquist et al[33] and Tang et al[34] identified inflammation and implant oral hygiene as critical factors of the bone loss around the implants. There is no other widely accepted way to evaluate the peri-implant soft tissue, so the GI, PI, CI, and the width of the keratinized tissue were measured in a standardized approach for this study. This method can be reproducible by different examiners and can be utilized for comparison of studies.

Greenstein and Cavalaro[30] reviewed the literature to determine the clinical significance of keratinized gingiva around implants. They mentioned that the presence of keratinized tissue is advantageous. However, the differences between these 2 groups were small. They concluded that the need for keratinized gingiva is patient specific, and it is difficult to predict which patients would benefit from tissue grafting.[30] The results of the present study suggest significantly less dehiscence on the facial aspect of the implants when more than 2 mm keratinized tissue was present. This conclusion is in agreement with the results of Bourni et al[44]; the authors concluded that an increased width of keratinized gingival (>2 mm) is associated with soft tissue health and less bone loss.

Many studies have focused on the marginal bone loss around implants and determining how much bone loss can be clinically acceptable. Van Steenberghe[45] mentioned that 1-mm bone loss is expected during the first year of implant function. Albrektsson et al[46] suggested 0.2-mm annual bone loss after the first year. Cehreli et al[35] reviewed the literature to evaluate the marginal bone loss around the implants supporting overdentures. The majority of the studies included in this review utilized periapical radiographs taken with a long cone. Acknowledging the difficulty in standardizing the measurements in periapical radiographs, this study reported bone loss as being equal to or more than one-third of the implant length.[29] This provided repeatability in the measurements yet may underestimate the incidence of having significant bone loss. Nineteen percent of the implants had developed significant bone loss, based on the above criteria. All these implants were clinically stable without the presence of purulence abscess or other type of pathoses. More studies are required to determine the important criteria for the evaluation of the peri-implant tissue.

The evaluation of the prosthesis and the supporting implants provides sufficient data that IODs are predictable treatment option. Patients and dentists need to be aware of the high incidence of complications and the maintenance that is

related to overdenture treatment.[6,35] The main surgical and implant complications were related to bone loss around the implant and soft tissue dehiscence. Goodacre et al[40] found the peri-implant dehiscence to be the most common soft tissue complication (7% of the implants). Other surgical complications that have been reported in the literature are hemorrhage, neurosensory disturbances, and mandibular fracture.[40]

The majority of complications found in this study were prosthetic in nature. A significant number of patients being restored with Locator attachment were found clogged with debris. This could distort the plastic insert and compromise the retention and fitting of the prosthesis. There were 5 patients that reported difficulty in placing or removing the prosthesis. The most common prosthetic complication was broken denture teeth followed by worn or missing overdenture inserts. The incidence of broken acrylic teeth in relation to the functional duration of the overdenture reveals that fracture of denture teeth can occur even during the first year following the delivery of the prosthesis. The percent of broken denture teeth in relation to the number of functioning prostheses increases with the number of years (12% for 1 year compared with 33% for 5 years in function; Table 10). In this study, there was a higher incidence of broken denture teeth in IOD when opposing IOD or natural teeth compared with the incidence of broken teeth in IOD opposing conventional dentures.

Comparing conventional dentures to IOD, the main complication of conventional denture is the loss of retention (86%).[47] The IODs have a higher incidence of broken teeth (74%) than conventional dentures (31%).[47] Goodacre et al[40] reported that the most common complication is the loosening of the overdenture clip attachment (30%), followed by need to reline (19%) and prosthesis fracture (12%). A similar high need for matrices replacement due to wear or damage has been reported by other authors.[3,10,48] Wear of the overdenture insert is an expected outcome over time and should be considered a component of maintenance and not a complication. The high incidence of prosthetic complications requires regular recall and a well-established maintenance program for patients. This should be part of the treatment planning process and communication with patients.

In this study, a retrospective evaluation of ISDs at the UIC advanced prosthodontic clinic was completed. However, as such, the data should be interpreted with caution. The number of patients was limited to those who were treated in the department and were willing to participate in the study. The patient pool is not representative of the general population relative to the patients' medical history. The number of maxillary overdentures that were examined was also limited. Since the study was cross-sectional rather than longitudinal, patient previous conditions were not documented. As a consequence, the results only show the biological variability among different patients.

Conclusion

Clinical examination and patients' perception revealed that IOD is a treatment option that can predictably restore patients' function and improve their quality of life. Minor complications are common for IOD therapy and, as such, patients need ongoing maintenance care. IOD can be a successful treatment option in Advanced Prosthodontic Programs for the completely edentulous population.

Abbreviations

CI: calculus index
GI: gingival index
IOD: implant-supported overdentures
OHIP-14: Oral Health Impact Profile
PI: plaque index
UIC: University of Illinois at Chicago

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