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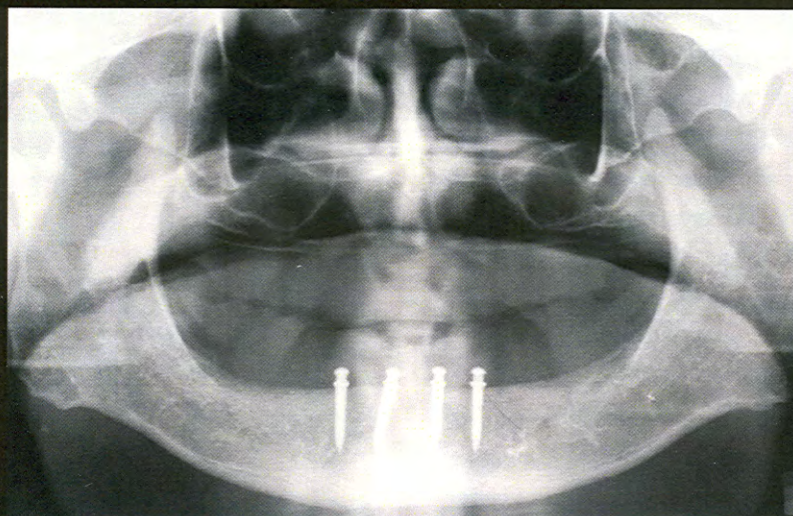
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IMMEDIATE LOADING OF NARROW-DIAMETER IMPLANTS WITH OVERDENTURES IN SEVERELY ATROPHIC MANDIBLES

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Oral rehabilitation using two to four implants to support mandibular overdentures has been shown to have success rates of approximately 96% with implants placed in a one- or two-stage procedure. The purpose of this study is to evaluate 10 consecutive cases of immediately loaded, narrow-diameter implants (NDIs) as support for overdentures in severely atrophic mandibles, and report on implant/prosthetic survival rates and patient satisfaction. Overall implant and prosthetic survival rates were 94.1% and 100%, respectively.

Learning Objectives:

This article discusses the implant/prosthetic survival rates and patient satisfaction for immediately loaded, narrow-diameter implants (NDIs). Upon reading this article, the reader should:

- Better understand how to evaluate NDIs as support for overdentures.
- Become more familiar with determining whether NDIs are more efficient, as opposed to standard-diameter implants, for a specific case.

Key Words: narrow-diameter, implant, immediate loading, overdenture, edentulous

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Conventional mandibular dentures for patients with severely atrophic mandibles often present retention, phonetic, and functional complications, as well as patient discomfort due to instability.¹ Endosseous implants have been successfully used to restore edentulous mandibles with implant-supported fixed partial dentures, hybrid prosthetic dentures, and removable overdenture prostheses.² Oral rehabilitation using two to four implants to support mandibular overdentures has been shown to have success rates of approximately 96% with implants placed in a one- or two-stage procedure.^{3,7} Numerous authors also have addressed patient satisfaction with mandibular implant-supported overdentures.⁸⁻¹² Meijer et al reported that patients with mandibular overdentures supported by two implants had higher satisfaction scores than patients who had complete denture treatment.¹¹

Atrophy of edentulous jaws may, however, limit implant placement in the mandible. In addition, anatomic limitations and resorbed alveolar ridges may compromise implant number, length, and position.¹³ The use of standard-diameter implants to support an overdenture often requires ridge augmentation in order to ensure sufficient bone volume. In addition, in patients of advanced age with serious medical problems or using anticoagulant therapy, the placement of more than one standard implant has been shown to have a statistically significant increased risk of surgical complications.¹⁴ NDIs placed with flapless surgery to support pre-existing conventional dentures present a method of restoring patients with atrophic mandibles. Advantages of this procedure include implant placement without any bone augmentation surgery, minimally invasive surgery resulting in little bleeding, decreased pain, and reduced patient expense.

Narrow-diameter (ie, 1.8 mm) implants were originally introduced and used to support provisional restorations in a single-stage surgery; these implants were then immediately loaded.¹⁵⁻¹⁹ While transitional implants were generally removed at the end of the provisionalization period, NDIs became osseointegrated with similar percentages of bone-to-implant contact, as was achieved with conventional machined-surface implants.^{20,21} A novel line of titanium alloy NDIs (ie, Atlas, Dentatus USA, New York, NY) was recently introduced and approved for use

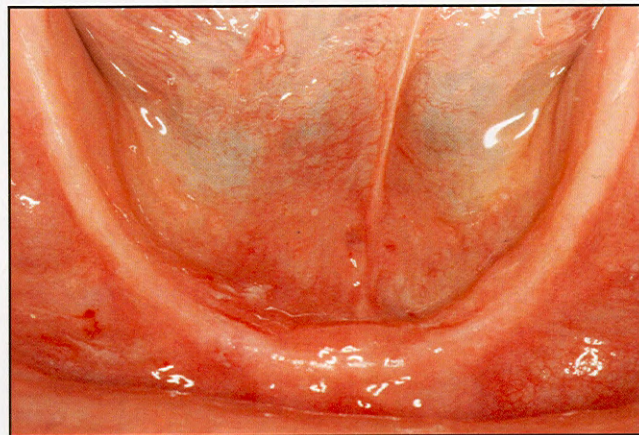


Figure 1. Occlusal view of the atrophic mandibular ridge.

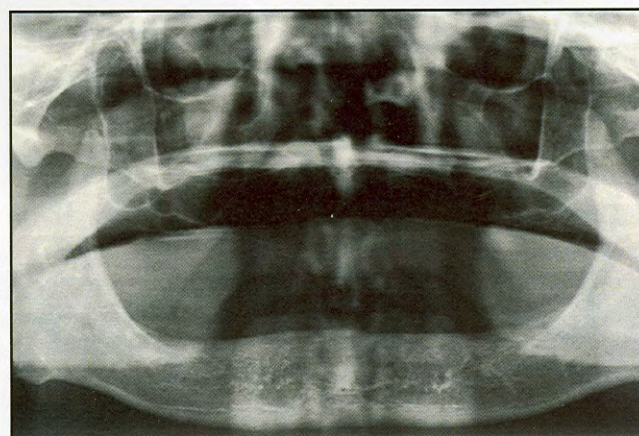


Figure 2. Preoperative panoramic radiograph showing an atrophic mandible.

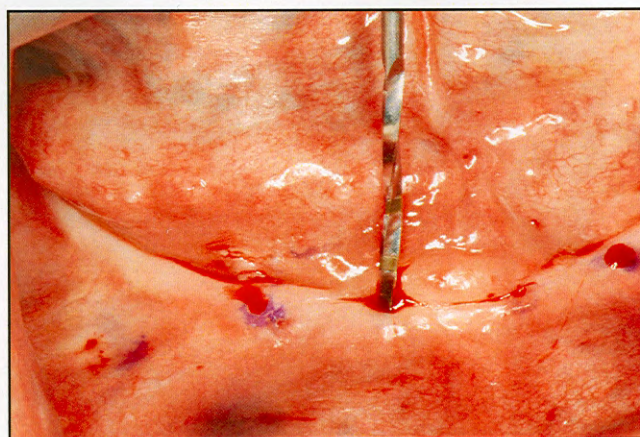


Figure 3. Profile drill with 7-mm, 10-mm, and 14-mm markings. Osteotomies are performed with the 1.8-mm drill at 800 rpm under copious irrigation.

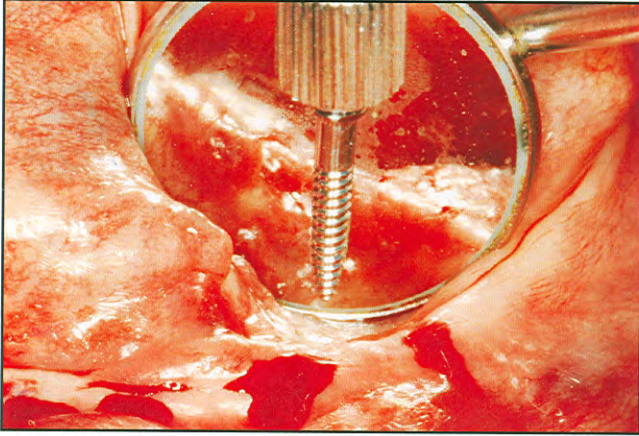


Figure 4. A 2.4-mm-diameter narrow-diameter implant (ie, Atlas, Dentatus USA, New York, NY) is placed with a manual driver.

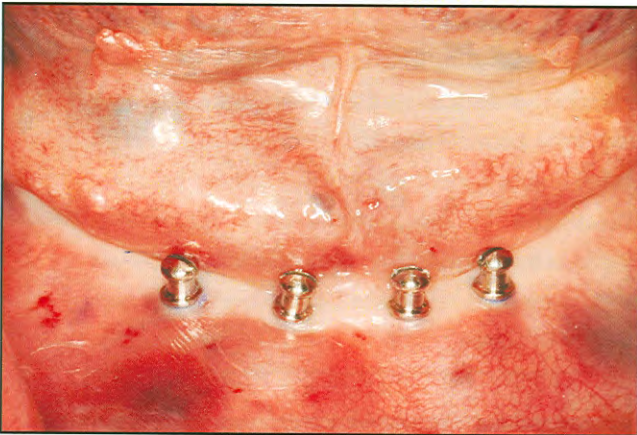


Figure 5. Final positioning of the NDIs with their low-profile prosthetic heads.



Figure 6. Occlusal view of the seated implants.

as conventional implants. These were designed as single-piece implants composed of screw-retained or cement-retained attachment superstructures. These implants have a self-threading, tapered screw design with diameters of 1.8 mm to 2.4 mm and embedded lengths of 7 mm, 10 mm, or 14 mm.²²

The purpose of the current study was to evaluate 10 consecutive cases of immediately loaded NDIs as support for overdentures in severely atrophic mandibles and report on the implant/prosthetic survival rates and patient satisfaction.

Materials and Methods

Clinical data were obtained retrospectively from an Implant Dentistry Database (IDD) at the Department of Periodontology and Implant Dentistry, New York University College of Dentistry (NYUCD) Krises Dental Center. This data set was extracted as de-identified information from the clinical information obtained from the routine treatment of patients. The IDD was certified by the Office of Quality Assurance at NYUCD. This study was in compliance with the Health Insurance Portability and Accountability Act (HIPAA) requirements.

Between 2004 and 2007, 10 patients (ie, 3 males, 7 females), mean age of 58.25 (ie, range 30 to 83), received a total of 34 NDIs (ie, 2.4 mm, Atlas, Dentatus USA, New York, NY) (Figures 1 through 10). Inclusion criteria consisted of patients who were dissatisfied with their conventional mandibular dentures due to lack of stability in function, and in whom there were no contraindications for implant placement. Panoramic radiographs were obtained, and two to four narrow-diameter, one-piece dome-type implants were placed in the mandibular anterior area between the foramina using a flapless surgical procedure. The patient's pre-existing mandibular denture was then relined with a resilient silicone material (ie, Tuf-Link Silicone Material, Dentatus USA, New York, NY) to establish adequate retention and allow immediate function. A patient interview with subjective evaluation was performed two months postoperatively. This interview also included the patient's evaluation of his or her previous dentures. In the present study, a patient satisfaction questionnaire (PSQ) was used to evaluate and compare the



Figure 7. Use of fit-checking material with implant-location markings to determine areas requiring adjustment.

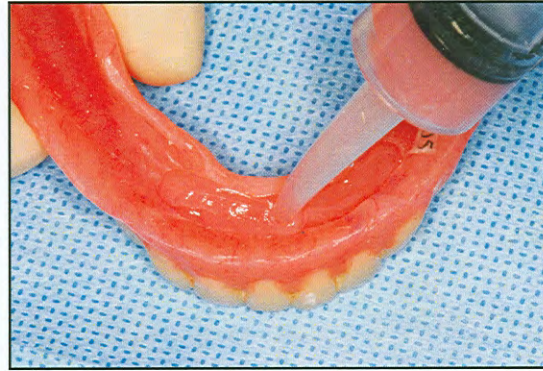


Figure 8. A silicone reline material is subsequently used to fill the channel.

satisfaction of patients who had previously worn conventional dentures (CD) and who now function with narrow-diameter, implant-supported overdentures (NDISO).²³

Results

A total of 34 implants were placed in 10 patients. Two of these implants failed within two months of loading. All 10 patients functioned with their NDISOs throughout the entire study period. This represents an overall implant survival rate of 94.1% and prosthetic survival rate of

100% (Table 1). Patient satisfaction questionnaire scores reported that NDISO resulted in improvement in function (Q1), stability (Q1), comfort (Q2), fitness (Q3 and Q4), occlusion (Q4), satisfaction (Q5, Q8), speech (Q6 and Q7), and social life (Q9) compared to the wearing of CD (Tables 2 and 3).

Discussion

Mandibular overdentures with different attachment designs supported by two to four implants have shown

Table 1

<i>Implant and Prosthesis Survival of NDI-Supported Overdentures</i>						
Patient Number	NDIs Placed	NDIs Survived	Number of Failures	Length of Time With NDISO (Months)	Implant Survival Rate (%)	Prosthesis Survival Rate (%)
1	4	3	1	24	75	100
2	4	4	0	36	100	100
3	2	2	0	27	100	100
4	4	4	0	23	100	100
5	4	4	0	29	100	100
6	4	4	0	15	100	100
7	4	3 (4)	1*	15	75	100
8	2	2	0	30	100	100
9	4	4	0	15	100	100
10	4	4	0	14	100	100
Total	34	32	2	22.8	94.1	100

* Replaced with another NDI two months following implant failure and removal (ie, two months post placement).

Table 2

Patient Satisfaction Questionnaire (PSQ)

1. Does your lower denture stay in place during function? (0-10)
2. Are you comfortable with your lower denture? (0-10)
3. How well does your lower denture fit? (0-10)
4. Do your upper and lower dentures fit well together? (0-10)
5. Are you satisfied with your lower denture? (0-10)
6. How well do you speak with your lower denture? (0-10)
7. How well do people understand you when you speak? (0-10)
8. How happy are you with your facial appearance with your dentures in place? (0-10)
9. Do you feel comfortable with your social life with your dentures? (0-10)

high implant survival rates with various implant systems using submerged, non-submerged, and immediately loaded protocols. These clinical trials ranged from six months to 10 years (Tables 4 and 5).

The present study is the first to present longitudinal results (ie, range 14 to 36 months) of immediately loaded, non-splinted NDIs used to support overdentures, with a resulting 94.1% implant survival rate. The NDI survival rate (ie, two failures of 34 placed implants) over a 14- to 36-month period is similar to the 96.4% success rate reported in a study of conventional unsplinted implants immediately loaded with overdentures in 10 patients over a 12- to 30-month period.²³ Park et al reported on

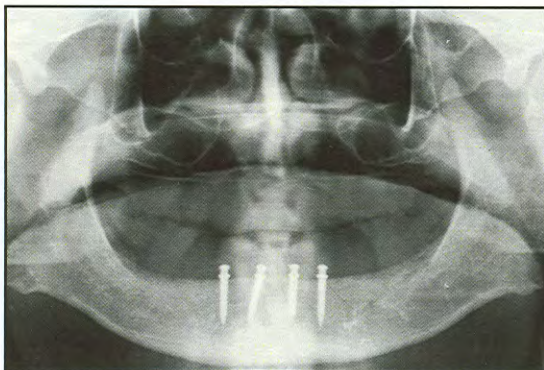


Figure 9. Postoperative panoramic radiograph of four NDIs placed between the foramina.

Table 3

Results of Patient Satisfaction Questionnaire*

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
CD	3	3.4	2.2	4	1.6	5.4	7.6	7.2	5.6
NDISO	7.8	8.1	8.6	9	8.2	9.3	9.4	8.4	8.4

* 0 = Very Dissatisfied, 10 = Very Satisfied

the long-term survival of NDIs (ie, 1.8 mm) with an overall survival rate of 85.9%.²⁴ The survival rate in the mandible (93%) was greater than that in the maxilla (79.4%) 36 months following immediate loading.²³ Simon and Caputo evaluated the removal torque of immediately loaded transitional endosseous implants in humans and reported that values were significantly higher in the mandible (ie, 24.0 ± 7.3 Ncm) than in the maxilla (ie, 16.1 ± 4.8 Ncm).²² These studies demonstrated that stronger integration occurred in the mandible with higher survival rates of NDIs compared to those placed in the maxilla. In the present study, two to four NDIs were inserted in severely atrophic mandibles in order to support pre-existing dentures.



Figure 10. View of the relined, NDI-supported mandibular overdenture following treatment.

Table 4

<i>Survival Rates of Non-Immediate-Loaded Implants Supporting Mandibular Overdentures</i>						
Name/Year	Implant Type	Total Implants (N)	Implants/Overdentures (N)	Attachment Design	Observation Time (Mean)	Implant Survival Rate (%)
Davis et al 1996	Astra	52	2/3	Single	3 y	99
Heckmann et al 2004	TPS	46	2	Single	10 y	100
Quirynen et al 1991	Brånemark	163	2	Bar/Single	4-48 mo (19.7)	98.6
Mericske-Stern 1993	ITI Type F/ Bonafit	88	2	Bar/Single	36-84 mo (61)	98.9
Gotfredsen et al 1993	Astra	40	2	Bar/Single	24 mo (24)	97.5
Naert et al 1994	Brånemark	72	2	Bar/Single	3-24 mo (12.4)	100
Gotfredsen et al 2000	Astra	52	2	Bar/Single	5 y	100
Naert et al 2004	Brånemark	72	2	Bar/Single	10 y	100
John et al 1992	Brånemark	393	2	Bar	12 mo (12)	96.2
Batenburg et al 1994	IMZ	114	2	Bar	12-57 mo (30)	97.4
Versteegh et al 1995	ITI Type F	135	3/4	Bar	45-109 mo (70)	74.8
Leimola-Virtanen et al 1995	TPS	166	4	Bar	3-10 y (5.6)	91.5
Wisniewer et al 1995	TPS	218	2/3/4	Bar	66-119 mo (80)	96.8
Jemt et al 1996	Brånemark	393	2	Bar	5 y	94.5
Geertman et al 1996	Brånemark/ IMZ Astra	116	2	Bar	12 mo (12)	98.3
Makkonen et al 1997	Astra	78	4	Bar	5 y	97.4
Heydenrijk 2002	IMZ	40 40	2	Bar	1 y	97.5 100
Mau et al 2003	TPS	414 852	2 4	Bar	5 y	95 92
Meijer et al 2004	IMZ TPS	58 64	2 2	Bar	10 y	93 86
Meijer et al 2004	IMZ Brånemark ITI	60 60 60	2 2 2	Bar	5 y	98.3 98.3 100
Visser et al 2005	IMZ Brånemark	180	2/4	Bar	5 y	99

Table 5

Survival Rates of Immediate-Loaded Implants Supporting Mandibular Overdentures						
Name/Year	Implant Type	Total Implants (N)	Implants/Overdentures (N)	Attachment Design	Observation Time (Mean)	Implant Survival Rate (%)
Roynesdal et al 2001	ITI	20/20	2	Single	24 mo	100
Ormianer et al 2006	Zimmer	28	3	Single	12-30 mo	96.4
Gatti et al 2000	ITI	84	4	Bar	25-60 mo (37)	96
Chiapasco et al 2001	Brånemark	40/40	4	Bar	24 mo	97.5/97.5
Tawse-Smith et al 2002	SteriOss/ Southern	48/48 C = loaded at 12 weeks T = loaded at 6 weeks	2	Bar	24 mo	SteriOss C- 87.5/T-70.8 Southern C-83.3/T-100
Gatti et al 2002	Brånemark	20/20	4	Bar	24 mo	100
Chiapasco et al 2003	Ha-Ti/ITI/ Brånemark/ Frialoc	328	4	Bar	3-8 y	91.6
Attard et al 2005	TiUnite/ Brånemark	70/111	2	Bar	12 mo	95/95

The dentures, which were relined with a silicone material and immediately loaded, functioned with an implant survival rate of 94.1%, which is slightly higher but similar to the study for the mandible by Park et al.²⁴

Two NDIs failed in two patients. The first NDI failure occurred two months following immediate loading. This may have been the result of misalignment, which induced excessive forces during the initial healing phase. The use of the three remaining NDIs placed in this patient, however, allowed the prosthesis to maintain adequate function. Two months following the removal of the failed NDI, it was replaced by an NDI of similar size with flapless surgery and immediate loading. The other NDI that failed was placed into a fresh extraction socket. Failure occurred one month following placement. This might have been the result of implant micromovement and loss of initial stability during the first three weeks of socket bone remodeling. To date, there has been a 100% prostheses survival rate in the 10 reported cases.

Reconstruction of a severely resorbed mandible with standard implant placement may require multiple grafting procedures prior to, or in conjunction with, implant placement. In the present study, NDIs placed with flapless surgery in severely atrophic mandibles resulted in limited bleeding during the surgery and minimal postoperative discomfort and swelling. The surgery was expedient, and ridge augmentation procedures were avoided. The procedures represented a reduced risk to patients who were advanced in age (ie, 3 of 10 patients), had serious medical problems (ie, 1 of 10 patients) or were using anticoagulant therapy (ie, 1 of 10 patients). Patients were also able to maintain the same vertical dimension of occlusion by using the pre-existing denture supported by the NDI that was placed with flapless surgery.

Flapless implant placement also decreased the post-surgical denture shifting that is often caused by healing of a sutured flap. Immediate loading in function was achieved with the patient's denture at the time of implant surgery.

Use of low profile ball attachments (ie, 3 mm) decreased the risk of lateral overloading forces in the initial healing phase of the loaded implants. The procedure utilized less expensive implants with flapless surgery and therefore resulted in reduced cost of treatment.

The patient satisfaction questionnaires indicated that following two months of immediate function with NDISOs, patients cleaned their dentures very well, three times a day, and removed them at night. Patients reported wearing the NDISO for longer periods of time than the CD during the day. There was also a significant increase in patient satisfaction with improved denture retention during function and improved patient comfort compared to CDs. There was a higher satisfaction level reported with the occlusion of the prostheses, as well as an improvement in reported ability to understand the patient's speech with NDISOs. The data from the present study also showed that patients had a significant increase in comfort and confidence with the NDISO as compared to complete dentures.

Conclusion

In this study, full mandibular dentures supported by non-splinted, dome-shaped NDIs provided immediate occlusal loading and function with high survival rates of both the NDIs (ie, 94.1%) and prostheses (ie, 100%).

When asked to evaluate and compare the NDISOs and CDs, patients reported an increase in comfort, function, stability, fit, occlusion, satisfaction, phonetics, and social life over an average of 22.8 months (ie, range 14 to 36 months). To date, the use of immediately-placed NDIs to support removable overdentures in the mandible has shown excellent results. Further studies are required to determine long-term success and predictability of this treatment modality and possible applicability for NDI-supported maxillary overdentures.

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The authors declare no financial interest in any of the products referenced herein. For a complete list of references cited in Tables 4 and 5, please contact the authors. The authors mention their gratitude to Sang-Hee Park, Sang-Jong Choi, Michele Landoli, Yung-Sang Park, and Tae-Sung Kim for their assistance in the case treatment.

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