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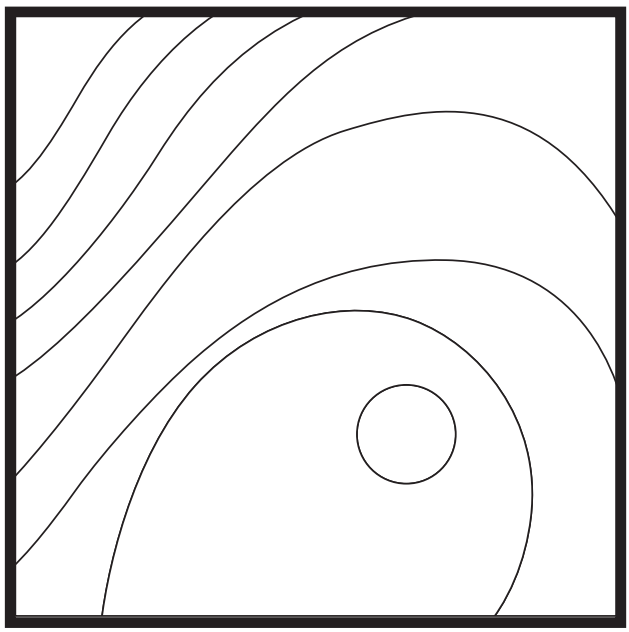

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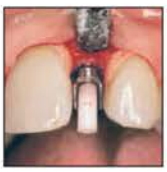
Narrow-Diameter Implants: A Restorative Option for Limited Interdental Space



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The present study reports on the results of the use of a screw-retained narrow-diameter implant (NDI) system as an option for implant placement in areas of limited bone volume. This retrospective report followed 48 NDIs in 27 patients for 1 to 5 years postloading. No implant failures were reported, yielding a 100% survival rate. The screw-retained attribute of this system allows retrievability of the restorations, which may require replacement because of porcelain fracture, chipping, or a desire to change color. The three diameters available—1.8 mm, 2.2 mm, and 2.4 mm—allow flexibility for a variety of narrow edentulous spaces. These NDIs present a cost-effective alternative for restoring limited spaces with implant restorations, without the bone augmentation or orthodontic procedures required for conventional fixed restorations. The NDI system is approved by the U.S. Food and Drug Administration for long-term use. (Int J Periodontics Restorative Dent 2007;27:449–455.)

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Dental implant restorations have been documented to have a high degree of success for completely and partially edentulous patients.[1–5] In the latter category, the replacement of a single missing tooth with an implant-supported restoration has widespread use, with high rates of success reported.[6–10] The advantages of such a restoration include construction of a freestanding restoration, ease of home care, and the avoidance of a removable or fixed partial denture. Preparation of healthy, noncarious teeth adjacent to the edentulous area is thus avoided. An additional advantage to the implant restoration is the maintenance of the alveolar bone, which otherwise would undergo resorption with other restorative options.[11–14] Moreover, the long-term benefits of freestanding implant-supported crowns include the fact that the crowns and surrounding tissue are accessible and can be hygienically maintained by ordinary home care procedures.

A requirement for implant placement is the presence of adequate bone volume and horizontal interdental space to allow standard-diameter (4.0 mm or greater) implants to be

Fig 1a *Preoperative facial view. Note the maxillary left peg lateral.*

Fig 1b *Close-up view of maxillary lateral incisor prior to extraction. Note the gingival recession and loss of attachment.*

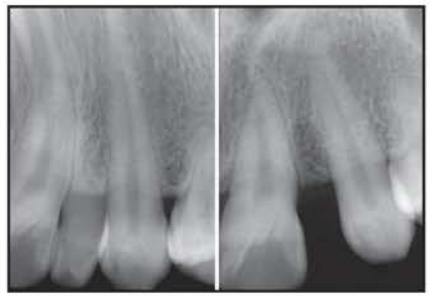


Fig 1c (left) *Preextraction periapical radiograph of maxillary left lateral incisor.* (right) *Postextraction periapical radiograph of healed maxillary left lateral incisor space, with less than 4 mm between adjacent teeth.*

placed. Procedures to increase bone volume, including guided bone regeneration and block grafting, have been used to increase available bone. Implants placed in regenerated bone show high degrees of success.[15,16] Implant manufacturers have introduced smaller-diameter implants (3.0 to 3.5 mm) in an attempt to solve the space problem. However, these implants require a minimum mesiodistal space of 6.0 to 6.5 mm to allow adequate implant-to-tooth distance.[17–19] Narrow-diameter implants (NDI) with a diameter of 1.8 mm were originally introduced as transitional implants that would help patients undergoing implant therapy avoid removable provisional dentures; these NDIs were ultimately intended to be removed.[20,21] However, these implants became osseointegrated and showed a bone-to-implant contact similar to that of implants with conventional diameters.[22] Transitional implants using cementable provisional restorations functioned well but occasionally failed because of repeated removal (tapping off), which caused macromovement of the implants.[20] Approximately 5 years ago, narrow-diameter titanium (Ti) alloy implants allowing screw-retained restorations (ANEW) were introduced by Dentatus. Based on the successful use of these implants over extended periods of function, approval of the US Food and Drug Administration was obtained for long-term use. The Ti alloy narrow-body implants are currently available in diameters of 1.8, 2.2, and 2.4 mm and in lengths of 7, 10, and 14 mm.

The present study is a retrospective report of 48 NDIs in 27 patients followed for 1 to 5 years postloading. All implants and prosthetic components were manufactured by Dentatus and placed either at the Department of Periodontology and Implant Dentistry, New York University Kriser Dental Center, or in the office of one of the authors (SJF). All were placed and provisionalized during the same visit.

Method and materials

The following procedures were performed prior to implant placement (Figs 1a to 1c).

1. A cancer screening was done.
2. A full-mouth examination for caries and periodontal disease was carried out.
3. Periapical radiographs were taken, and patients were referred for computerized axial tomographic (CAT) scanning.
4. The edentulous area was measured clinically and on the CAT scans using SimPlant technology (Materialise). Implant placement was simulated on the CAT scan.
5. Informed consent was obtained orally and in writing. The patients were informed of the benefits and risks, and all other restorative options were explained. The patients were also informed that one or more NDIs would be placed, with a provisional restoration fabricated and inserted during the same visit.

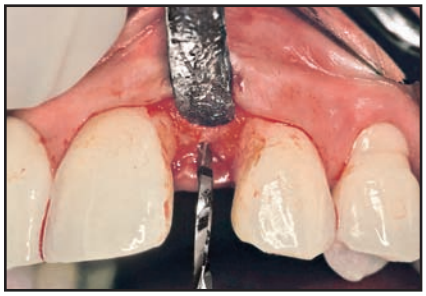
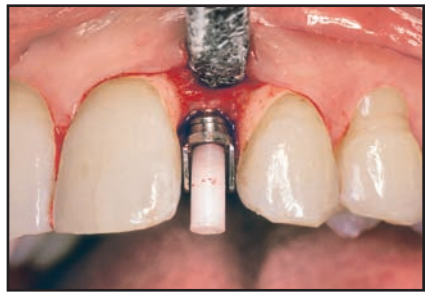


Fig 1d (left) *View of the 1.3-mm twist drill preparing the osteotomy for implant placement.*

Fig 1e (right) *The indexing abutment and nonhygroscopic screw cap attached to the abutment head.*



6. Impressions were made, study casts created, and a surgical guide fabricated on an ideal waxup.

Implant placement

1. In all cases, facial and lingual infiltration utilizing lidocaine with epinephrine 1:100,000 were used to obtain local anesthesia. In patients unable to tolerate this anesthetic, carbocaine 3% without epinephrine was used.
2. A crestal incision was made, and a limited soft tissue flap was reflected to expose the crest of bone.
3. With a 1.3-mm twist drill with 7-, 10-, and 14-mm laser markings (corresponding to the size of the implants), osteotomies were drilled at 1,500 revolutions per minute using constant copious irrigation (Fig 1d). In areas of dense cortical bone (mandibular anterior area), the drill was inserted two or three times to the desired depth to allow stress-free placement of the implants.
4. With the handpiece adapter or manual driver included in the surgical kit, the implants were placed to the desired depth at 30 revolutions per minute. A manual tactile driver was used to achieve the final insertion depth. This hand tapping was performed to maximize initial stability of the implant.

Fabrication of the provisional

1. The titanium indexing abutment was placed over the implant square head in contact with the 3.2-mm implant platform. (This coping may be placed in a buccolingual or mesiodistal direction.)
2. A nonhygroscopic acrylic resin screw cap was inserted over the implant head, locking the index coping firmly in place with the manual square driver (Fig 1e). The open end of the screw cap was plugged with a brass insert to prevent the acrylic resin from blocking its access.
3. The proper mold and shade of polycarbonate crown was selected, or laboratory fabrication of a hollow crown from an ideal waxup was performed, in advance of the clinical procedure.
4. The provisional restoration was fabricated using the polycarbonate crown, laboratory-prefabricated hollow crown, or a vacuum-formed shell filled with quick-curing acrylic resin (Jet, Lang Dental). The provisional was trimmed and polished. The screw cap was disassembled by counterclockwise rotation with the square driver.
5. The provisional restoration was placed over the abutment and the occlusion adjusted so as to avoid contact in centric and excursive movements. The crown was reassembled with the screw cap. The screw opening was temporarily filled with visible off-color temporary acrylic resin for future access.

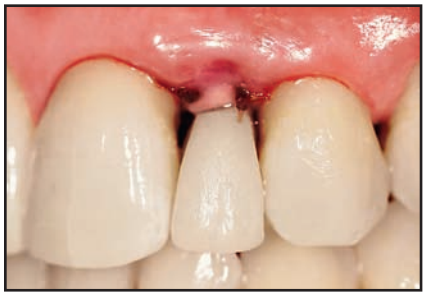
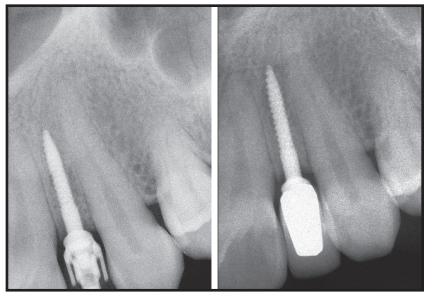


Fig 1f (left) *Following placement of the acrylic resin crown, the flap is sutured with 4-0 absorbable chromic gut.*

Fig 1g (right) (left) *Radiograph of the NDI and indexing abutment.* (right) *Radiograph of implant and definitive restoration 5 years after surgery.*



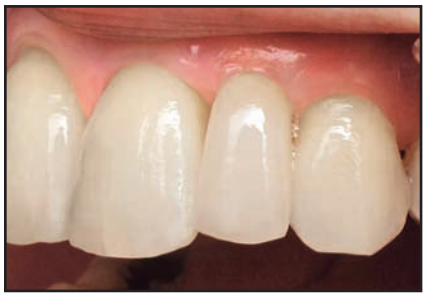
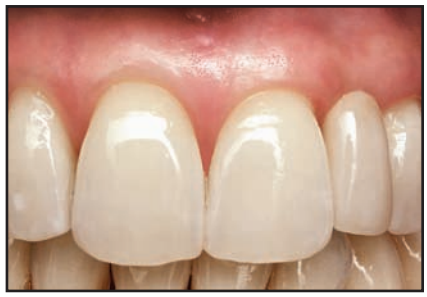


Fig 1h (left) *Clinical view of the definitive implant-supported porcelain crown.*

Fig 1i (right) *Facial view of the definitive lateral incisor implant restoration.*



6. The soft tissue flap was repositioned and sutured with absorbable interrupted 4-0 chromic gut sutures to obtain interproximal closure (Fig 1f).

All patients were placed on antibiotic coverage (amoxicillin 2,000 mg 1 hour prior to surgery, followed by 250 mg four times a day for 7 days following surgery; patients unable to take amoxicillin received clindamycin 600 mg 1 hour prior to surgery, followed by clindamycin 150 mg four times a day for 7 days). Patients were placed on 1.2% chlorhexidine rinse (Peridex, Zila Technical) twice a day for 3 weeks starting 2 days prior to surgery. Patients were instructed to avoid hard contact with the implant restoration for 3 to 4 months following surgery. Patients were also advised to lightly brush and gently floss the surgical area starting 3 weeks after surgery. Patients returned every 2 weeks for 2 months after surgery and once a month thereafter for 2 to 4 months for maintenance and monitoring of the area.

Approximately 4 months after implant placement in the mandible and 6 months after placement in the maxilla, the screw-retained provisionals were replaced with a metal-ceramic or acrylic resin crown using conventional impression analog transfer techniques for models and laboratory-constructed restorations.

Fabrication of the definitive restoration

1. The indexed impression coping was attached with the gray technical screw cap to the implant.
2. A closed-tray impression was made of the screw-attached index coping using elastomeric impression material (Reprosil Vinyl Polysiloxane Impression Material, Dentsply/Caulk); this was used for making an indexed master cast.
3. The transfer coping was attached to the analog and re-inserted into the impression with an implant analog.
4. The master cast was made with a soft tissue base for the construction of the restoration.
5. The definitive restoration was then fabricated using gold or plastic copings.
6. A porcelain-fused-to-metal crown was fabricated using conventional clinical and technical laboratory procedures (Figs 1g to 1i).

Results

In this study, 27 patients received 48 NDIs, which were loaded for periods of 12 to 64 months postinsertion. To date, no implant or prosthesis has had to be removed or replaced. Two screw-retained crowns loosened; the composite was removed and the screw cap was tightened without patient discomfort or interruption of the function of the implant restoration. Each patient has been recalled at 2- to 3-month intervals for maintenance and reexamination.

Discussion

Re-formation of the horizontal width around an implant requires a minimum distance of 1.5 mm between the implant surface and the neighboring tooth to allow maintenance of adequate interproximal bone. Standard-diameter implants of 4.0 mm or greater, therefore, require a mesial-to-distal edentulous distance of at least 7 mm between two teeth to place an implant and maintain the proper restorative distances. Moreover, standard-diameter implants require at least 2 mm of bone buccal to the implant to avoid bone resorption and gingival shrinkage, which then requires a greater apicocoronal dimension of the crown restoration. Restoration of the implant in such cases requires an artificially long implant crown, resulting in compromised esthetics.

Ridge augmentation procedures are often required to create adequate buccolingual bone to maintain a 2-mm bone thickness following implant placement. NDIs (1.8, 2.2, and 2.4 mm) present a solution for the aforementioned requirements of adequate buccolingual bone dimensions and proper implant spacing without the need for ridge augmentation. Because of their smaller diameters, NDIs also result in a greater thickness of remaining buccal bone following the osteotomies for implant placement. They also offer the advantage of immediate temporization; the patient thus avoids the use of removable provisional appliances or the need to go edentulous until the implant fully osseointegrates and is able to be restored. In the current retrospective study, implants were nonocclusally loaded immediately after placement of a provisional restoration for a period of 4 to 6 months before definitive impression and restoration. Each of the 48 NDIs has been in function for 1 to 5 years.

The 100% success rate of NDIs as used and documented in the present study is similar to that observed by Mazor and colleagues,[23] who reported on 32 single-tooth replacements in 32 patients. One implant failed as a result of "mechanical overload." Several differences, however, should be noted between the two studies. The implants used in the Mazor et al study were all 2.4 mm in diameter. All were immediately loaded at the time of placement. The implants used in the present study were 1.8, 2.2, or 2.4 mm, depending on the volume of remaining bone. The additional option of using a smaller-diameter implant in the present study allowed preservation of more bone in the implant site, both buccally and interdentally. The implants used in the current study (ANEW, Dentatus) allow

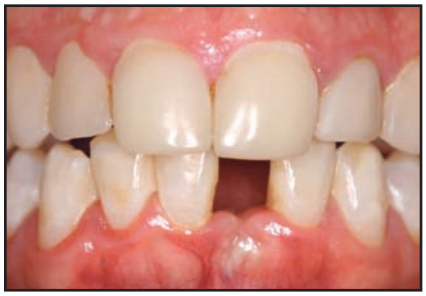


Fig 2a *Preoperative view of the missing mandibular left central incisor tooth.*

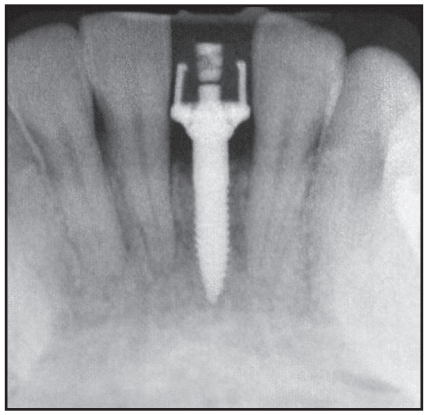


Fig 2b *Radiograph of the NDI (2.4-mm diameter and 10-mm length) with the indexing abutment.*

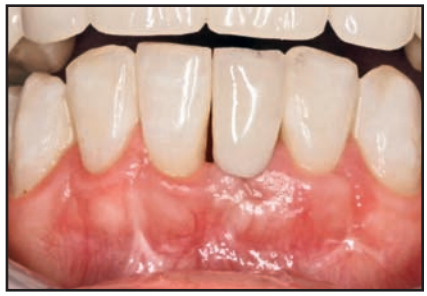


Fig 2c *Implant with a screw-retained metal-ceramic restoration.*

immediate loading and have been used with this protocol for multiple implants. However, in the present study, for the replacement of one or more teeth in patients who had enough remaining teeth to provide a stable, trauma-free occlusion, the authors felt that there was little need to load these implants early and risk macromovement with loss of osseointegration. The immediate, nonoccluding provisional provided for esthetics and performed as a space maintainer, thus avoiding adjacent tooth migration. The NDI system employed in the present study also has the advantage of delivering a screw-retained definitive restoration. This provides an option for retrievability, which is extremely useful should the crown require replacement because of porcelain fracture, chipping, or the desire to change porcelain color when the color of the adjacent teeth changes. The latter may occur as a result of aging, professional or home whitening procedures, or future additional restorations. These NDIs present a useful adjunct to the implant restorative armamentarium by providing an implant option in patients with congenitally missing incisors, reduced interdental space following orthodontic movement, retained primary incisors that are lost, one or two missing mandibular incisors (Figs 2a to 2c), or space collapse in the maxillary anterior area following a lack of needed orthodontic therapy.

Although there are several NDI systems available today, the data in the present study with the acrylic resin screw cap–retained system demonstrate similar high survival rates for the 1.8- to 2.4-mm-diameter implants.[24]

The advantage of the NDI system used in the present study is that it offers the same ease of insertion with a greater prosthetic flexibility and retrievability than purely cementable systems. Evaluation of these NDIs for long-term use will require additional multicenter prospective longitudinal studies.

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