# Fiber-Reinforced Resin Fixed Prostheses on 4 Short Implants in Severely Atrophic Maxillas: 1-Year Results of a Prospective Cohort Study

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**Purpose:** The aim of this study was to report on 1-year outcomes of fixed full-arch fiber-reinforced resin bridges on short implants in atrophic maxillary jaws.

**Materials and Methods:** A prospective cohort study was designed and patients with severely atrophic maxillas, corresponding to Cawood and Howell Classes V and VI, were included. Mesial and distal peri-implant bone levels were assessed on panoramic radiographs that were taken at the time of implant insertion (baseline) and during follow-up visits.

**Results:** Eighteen patients with 72 implants inserted in atrophic maxillary jaws were included in this study. All patients had a follow-up visit 1 year after loading. The cumulative 1-year patient-based implant survival rate was 88.8%, and the cumulative 1-year implant-based survival rate was 97.2%. The marginal bone level (MBL) was $-0.5 \pm 0.5$ mm at the time of loading (n = 72) and $-0.8 \pm 0.6$ mm (n = 72) after 1 year. The MBL depended substantially on the depth at the time of insertion. No prosthetic failure, such as chipping or fracture, occurred within the first year of loading.

**Conclusion:** Prosthetic rehabilitation of atrophic maxillas with prostheses supported by 4 4.0- × 5.0-mm or 3.0- × 8.0-mm implants seems to be a viable and cost-effective treatment option in the short term.
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The concept of supporting a full-arch fixed prosthesis on only 4 implants has proved a reliable treatment option for prosthetic restoration of atrophic jaws.[1] However, in edentulous posterior maxillas, severe bone atrophy, especially as a result of prolonged postextraction crestal atrophy and to a lesser degree from sinus pneumatization, can complicate implant rehabilitation.[2,3] It is the centripetal nature of maxillary atrophy that complicates implant insertion compared with mandibular insertion, because maxillas have a smaller jaw base with knife-edged ridges. In these cases, various approaches have been described in the literature, ranging from sinus grafting or other bone augmentation procedures to variations of implant lengths, from zygoma implants to ultrashort implants, for successful prosthetic restoration.[4-6] The sinus lift is currently considered the gold standard to increase bone volume in the posterior maxilla to allow for insertion of implants of conventional lengths (≥10 mm), providing 75% of patients with a

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sinus floor below the palatal plane—and thus reaching into the alveolar process—the opportunity for implant insertion.[7] Numerous studies have confirmed the favorable outcomes and excellent long-term results. However, augmentative procedures are time consuming and involve higher costs, higher levels of patient morbidity (especially when autologous bone is used for augmentation), and the risk of complications, such as postoperative sinusitis and graft failure.[8,9] Recently, several studies compared the results of ultrashort implants with implants of conventional length in combination with sinus augmentation procedures for prosthetic restoration of the posterior maxilla, and the implant survival rates of ultrashort implants were found to be comparable to implants of conventional lengths placed in augmented sinuses.[10-12]

The systemic review of the European Association for Q5 Osseointegration consensus conference by Thoma et al[11] and a recent meta-analysis by Fan et al[10] concluded that ultrashort implants offer a viable alternative with minimal complications (to the conventional treatment regime of sinus augmentation combined with implants of conventional length). Thus, the European Association of Dental Implantologists published a consensus statement that short implants are a reliable treatment option compared with implants with augmentation.[13] Ultrashort implants allow for cost-effective and time-efficient prosthetic restorations in 1 session with high levels of patient satisfaction.[11,14,15]

The aim of this study was to report on the 1-year outcomes of fixed full-arch fiber-reinforced resin bridges on short implants in atrophic maxillary jaws.

## Materials and Methods

A prospective cohort study according to the Good Clinical Practice Guidelines and the Declaration of Helsinki was designed after approval from the institutional ethical committee was obtained (EK number 018/2011). The results of the present study are reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) criteria.[16]

### INCLUSION AND EXCLUSION CRITERIA

Patients 18 to 80 years of age with severely atrophic maxillas corresponding to Cawood and Howell Classes V and VI (flat or depressed alveolar ridge form, inadequate in height or width) were included in this study after their written consent was obtained.[17]

The following exclusion criteria were defined: uncontrolled diabetes (hemoglobin $A_{1c}$, >6.5%); smoking (>10 cigarettes per day); alcohol abuse; untreated periodontitis of residual teeth; osteomyelitis; rheumatic disease; poor general state of health; bisphosphonate, interferon, or glucocorticoid therapy; untreated tumor disease; pregnancy; poor compliance; physical limitations interfering with oral hygiene; and participation in other medical studies up to 30 days before implant insertion.

### SURGICAL PROTOCOL

All patients received short (3.0- × 8.0-mm) or ultrashort (4.0- × 5.0-mm) calcium phosphate-coated Bicon implants (Bicon LLC, Boston, MA). The thinner implants were used solely in a knife-edged anterior region. The implant bed preparation differs from the insertion of threaded implants: The drilling is performed at 50 rpm without irrigation or by hand, and all accumulating autogenous bone of the osteotomy is harvested. After preparation, the implants are tapped into the bone using an insertion instrument. The prosthetic well is closed with a polyethylene plug and the implant is covered with the harvested autogenous bone from the osteotomy. When possible, a double-layer wound closure was performed, suturing the periosteum in the first step and the overlying mucosa in the second step.[18]

### PROSTHETIC AND MATERIAL PROTOCOL

Implants were left submerged for a period of at least 6 months of healing before being surgically exposed. In 1 session, the implants were uncovered, and an implant-level transfer impression and an impression of the opposing dentition and an occlusal registration were made. A Trinia (Bicon LLC) frame (metal-free fiber-reinforced hybrid material) was milled using a computer-assisted design and manufacturing process. The restorations were temporarily cemented with TempBond (Kerr GmbH, Rastatt, Germany) to allow for careful de-cementation in the event of prosthetic complications. Final cementation was performed using a carboxylate luting cement (Durelon; 3M ESPE Dental Products, St Paul, MN).

### PATIENT RECALL

Patients were enrolled in a recall program with follow-up visits 6 months after implant insertion followed by a 1-year examination. At each follow-up, the peri-implant soft tissues were inspected and an orthopantomogram was recorded.

### MEASUREMENT PROTOCOL

After calibration of the x-ray device was achieved, 2 of the authors (R.S. and F.W.) assessed the mesial and distal peri-implant bone levels on panoramic radiographs that were taken at the time of implant insertion (baseline) and follow-up visits (6 and 12 months after implant insertion). For this purpose, the following

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