

Management of vertical bone atrophy with 6.5mm extra-short implants: **An eight-year clinical and radiographic study**

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INTRODUCTION

Rehabilitation of posterior regions affected by significant vertical bone atrophy remains a considerable clinical challenge. When residual bone height is limited, commonly used procedures — such as maxillary sinus floor elevation, guided bone regeneration, or block grafting — may provide effective outcomes but often involve more invasive techniques, multiple surgical stages, and increased treatment time and cost. Short and extra-short implants have therefore been proposed as an alternative for selected cases, with long-term studies reporting survival rates above 98%¹⁻⁵.

Immediate loading protocols have also become increasingly established within implant dentistry. Evidence suggests that, where adequate primary stability is obtained, immediate loading may achieve outcomes similar to those of delayed loading, while potentially offering advantages for patient experience. Torque values of 30–45Ncm are

generally cited as minimum thresholds for single-unit restorations, and approximately 20Ncm for splinted prostheses⁶.

The use of immediate loading with reduced-length implants has broadened treatment options, though questions remain regarding their long-term behaviour. Reported survival rates vary between 87% and 96.6%, yet comparison across studies is limited by differing methodologies, including variations in drilling protocols, loading criteria, connection systems, and implant length classifications⁷⁻¹³. Some studies group implants up to 8.5mm in the “short” category, making it difficult to isolate the performance of genuinely extra-short implants.

Research focusing specifically on implants of ≤ 6.5 mm provides more reliable insight. Previous work by the authors has reported 100% survival of extra-short implants in posterior maxillary and mandibular sites,

including under compromised bone conditions⁸. These findings indicate that predictable outcomes may be achievable when planning, drilling protocols, and occlusal control are carefully managed.

This study presents a retrospective analysis of patients treated with 6.5mm implants placed in pairs and immediately loaded with splinted restorations. Unlike earlier reports, this series includes a larger number of cases and integrates clinical and radiographic follow-up to evaluate implant survival and crestal bone stability. The objective is to contribute further evidence regarding the suitability of extra-short implants as a minimally invasive option for managing vertical atrophy.

MATERIALS AND METHODS

A retrospective review was conducted of all patients treated in a private clinic in Vitoria, Spain, using 6.5mm extra-short implants restored under immediate loading. Only cases with at least 12 months of follow-up after loading were included.

Before treatment, all patients underwent a full diagnostic process, including cone-beam computed tomography (CBCT), study models, and diagnostic wax-ups. Three-dimensional evaluation of the remaining bone informed implant position, angulation, and diameter. Planning considered anatomical limitations, including the maxillary sinus and inferior alveolar nerve. Implants were placed using a biologically guided drilling protocol¹⁶, with insertion torque measured at placement to confirm suitability for immediate loading.

Provisional screw-retained splinted prostheses were fitted immediately after surgery to stabilise load distribution during osseointegration. Between three and six months later, these were replaced with definitive metal-ceramic fixed bridges or metal-resin hybrid prostheses.

Clinical and radiographic data were collected at the patient and implant levels. Variables included demographics, implant diameter and position, and any complications. Marginal bone loss was evaluated using the most recent panoramic radiograph for each patient. Radiographs followed standardised positioning protocols to improve consistency. Calibration

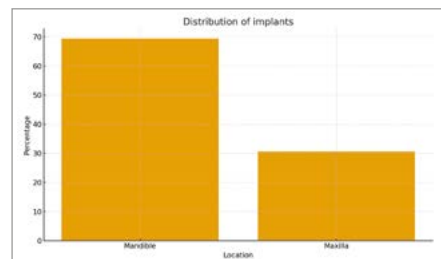


Fig 1: Distribution of implants between the maxilla and mandible

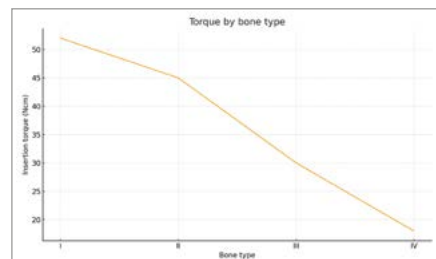


Fig 2: Insertion torque values according to bone type

was performed using software based on known implant length to account for magnification, and marginal bone measurements were recorded mesially and distally.

The Shapiro-Wilk test assessed normality before statistical analysis. Quantitative variables were expressed as means and standard deviations, and qualitative variables as frequencies and percentages. Implant survival was evaluated using Kaplan-Meier curves. Analyses were performed using SPSS v15.0.

RESULTS

18 patients received 36 extra-short 6.5mm implants restored with splinted prostheses under immediate loading. The mean patient age was 66.04 ± 5.12 years, and 55.6% were women. No patient presented systemic conditions that contraindicated implant placement or immediate loading. The mean follow-up period was 8.02 ± 1.47 years (range: six to 10 years).

Most implants (69.4%) were placed in the mandible, with the mandibular second molar the most frequent position (41.7%). The maxilla received 30.6% of implants. Diameters ranged from 3.3mm to 5.5mm; 3.5mm was the most common (38.9%). All implants achieved sufficient primary stability for immediate loading, with a mean insertion torque of 42.8 ± 12.6 Ncm.

No implant lost clinical stability or showed radiographic evidence of biomechanical complications during follow-up. Provisional and definitive restorations remained stable, with only minor occlusal wear noted and managed with routine adjustments. No significant mechanical complications or peri-implant inflammatory events were recorded.

Mean marginal bone loss at final follow-up was 0.52 ± 0.41 mm mesially and 0.47 ± 0.38 mm distally. No implants failed, resulting in a cumulative survival rate of 100%. Kaplan-Meier analysis showed no events across the observation period.

DISCUSSION

This study reports positive long-term outcomes for 6.5mm extra-short implants restored under immediate loading, with 100%

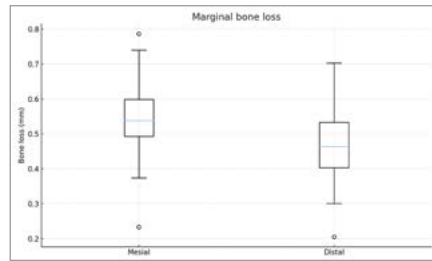


Fig 3: Mesial and distal marginal bone loss for the implants included in the study

survival over an average follow-up of eight years. These findings contribute to existing evidence indicating that reduced-length implants may perform comparably to standard-length implants when placed under controlled conditions¹⁻⁴.

Other studies have documented high survival rates for implants between 4 and 7mm⁹⁻¹⁰, even

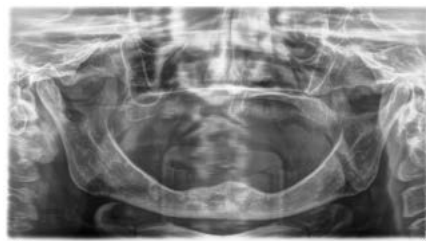


Fig 5: Initial radiograph of a patient seeking mandibular implant treatment due to the aesthetic and functional limitations of her existing removable prosthesis

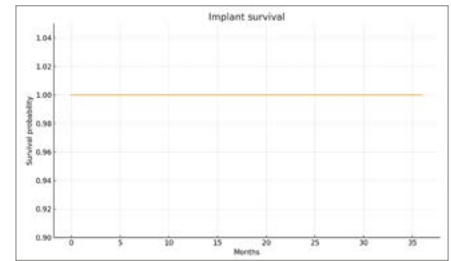


Fig 4: Kaplan-Meier survival curve demonstrating 100% implant survival over the entire follow-up period

in challenging anatomical conditions^{11-15,18}. Several factors may explain the outcomes in this study. The biologically guided drilling protocol aims to preserve bone structure and achieve stable primary fixation, which is particularly relevant for reduced-length implants. The mean insertion torque exceeded commonly recommended thresholds for immediate loading¹³⁻¹⁴.

The consistent use of splinted prostheses may also have contributed to favourable load distribution, reducing stress on individual implants and limiting micromovement during healing¹⁵⁻¹⁷. No significant prosthetic complications were observed, aligning with findings from recent reviews advocating splinting in similar scenarios¹⁸⁻¹⁹.

Marginal bone levels remained stable and well within established criteria for long-term



Fig 6 & 7: Intraoral views without prosthesis reveal a class III skeletal pattern, mucosal ulceration due to poor denture retention, and a narrow, thin-mucosa mandibular ridge consistent with bone atrophy



Fig 8 & 9: The patient with upper and lower removable dentures continues to exhibit an edge-to-edge occlusion, despite attempts to offset the skeletal class III due to maxillary and mandibular atrophy

implant success²⁰⁻²¹. Although some studies suggest that extra-short implants may show higher early crestal bone remodelling²²⁻²⁴, the controlled drilling protocol and splinted loading used here may have mitigated this effect.

Comparisons with previous research show similar patterns. Rossi et al²⁵ reported marginal bone changes of 0.4–0.5mm at one year for 6mm implants, while Degidi and Piattelli²⁶ observed 94.7% survival for immediately loaded implants ≤ 7 mm. The homogeneity of implant length and adherence to immediate splinted loading protocols may explain the consistency of outcomes in the present series.

Although the study includes a relatively long follow-up, its retrospective nature and limited sample size introduce inherent limitations. The findings may not be generalisable to all clinical settings. Nevertheless, the extended observation period provides insight into the long-term performance of extra-short implants, an area with comparatively limited published data.

Overall, the results support the use of extra-short implants within minimally invasive

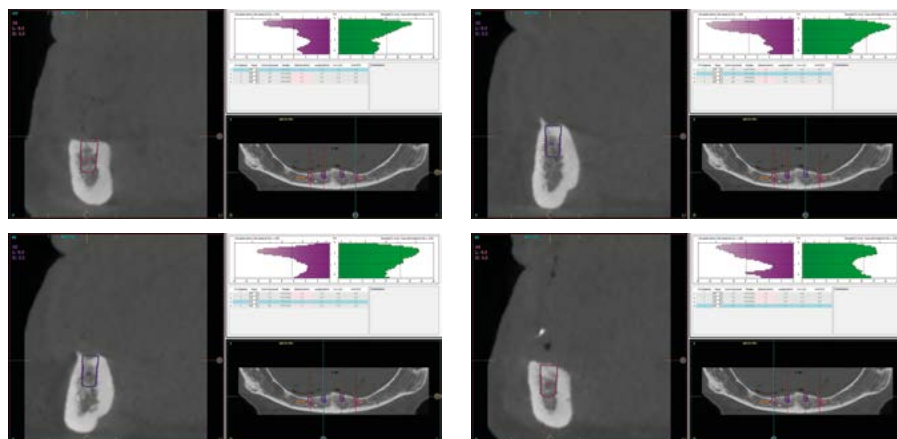


Fig 10-13: CBCT planning sections showing the planned placement of four 6.5mm reduced-diameter implants in the mandible. The combination of high bone density and advanced resorption may enhance peri-implant vascularisation while preserving remaining bone for potential future retreatment

treatment strategies, particularly where bone augmentation is not desirable or feasible²⁷.

CONCLUSIONS

Across an average follow-up of eight years, 6.5mm extra-short implants placed with a controlled surgical protocol and restored using splinted immediate loading demonstrated stable clinical and radiographic performance. The absence of implant failures, low marginal

bone loss, and lack of major prosthetic complications suggest that these implants may represent a viable option for managing vertical atrophy without the need for more invasive regenerative procedures. Larger prospective studies would help further validate these findings. **DA**

All images courtesy of BTI Biotechnology Institute.



Fig 14 & 15: Diagnostic wax-up and the framework design for the splinted immediate-loading prosthesis to be fitted for the patient.



Fig 16 & 17: Completed resin immediate-loading prosthesis, ready for delivery 24 hours after implant surgery



Fig 18 & 19: Clinical view of the patient with the immediate-loading prosthesis and newly placed complete denture

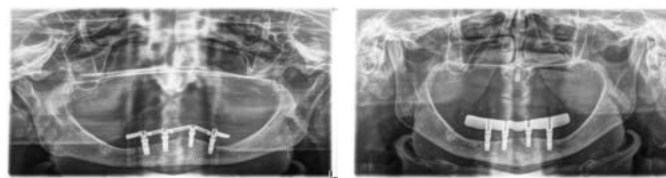


Fig 20: Immediate-loading complete prosthesis placed in the patient

Fig 21: Final radiograph at eight-year follow-up

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