RESEARCH | Article in Press

Short-term clinical and radiographic outcomes of DS PrimeTaper implants: a prospective cohort study in private practice

G. Esteve-Pardo · J. Amigó-Bardají · L. Esteve-Colomina

Received: 24 August 2025 / Accepted: 2 November 2026
© The Author(s) 2026

Abstract

Objectives To assess the short-term clinical and radiographic outcomes of the DS PrimeTaper EV implant system placed in routine private practice, with a focus on implant survival, success, marginal bone loss (MBL), complications, and patient-reported outcomes (PROMs).

Materials and methods This prospective observational cohort study evaluated the clinical and radiographic outcomes of DS PrimeTaper EV implants placed in two private practice settings. A total of 286 implants were placed in 154 patients and followed for an average of 14.9 months. Survival and success (MBL$\leq$0.5 mm, no signs of infection, mobility, or pain) were evaluated. Digital radiographs and PROMs questionnaires were analysed. Risk factors were explored through generalized estimating equations (GEE) and Kaplan–Meier survival analysis.

Results The overall survival rate was 95.1%. Most failures (71.4%) occurred within the first six months after placement. Failure rates were higher for premolars, narrow-diameter implants, and in the presence of healing complications ($p<0.05$). Mean MBL was 0.15 ± 0.39 mm; 81.6% of implants met the success criterion. Two cases of peri-implantitis and one case of buccal MBL due to prosthetic overpressure were reported. One prosthetic fracture occurred. ISQ2, mandibular site, and reduced loading time were associated with higher success rates. PROMs showed excellent satisfaction (mean 9.0–9.4/10), though slightly lower in periodontally compromised patients.

Conclusions DS PrimeTaper EV implants showed favourable short-term survival and low mean marginal bone loss in routine private practice. However, findings should be interpreted as preliminary because of the single-arm design, short follow-up, and limited number of failures. Patient satisfaction was high, and complications were rare. Clinical variables such as site, timing, and prosthetic protocol were associated with outcomes in exploratory analyses. Longer-term follow-up is warranted.

Trial registration ClinicalTrials.gov NCT05500755, registered August 15, 2022.

Keywords Dental implants · Implant survival · Marginal bone loss · Primary stability · Tapered implant design · Prospective cohort study · Patient-reported outcomes

This Article in Press is shared early to give you faster access to new research. It is citable and carries a permanent DOI. The final edited version will replace it automatically.



https://doi.org/10.1186/s12903-026-10414-2

Published online: 14 November 2026

Introduction

Oral implantology has undergone significant advances in recent decades, driven by the demand for more effective and durable restorative solutions. The design of the dental implant has been, and continues to be, the focus of extensive research and innovation by both academia and industry.

Primary stability, defined as the initial mechanical resistance of the implant to micromovements upon placement, is considered a critical factor for successful osseointegration and long-term survival of dental implants [1]. It is influenced by multiple factors, including bone density, the way the implant site is surgically shaped, and, importantly, the macrogeometry of the implant. Conical implant designs have shown enhanced primary stability, particularly in low-density bone, due to their ability to condense bone laterally and increase bone-to-implant contact area [2–4].

The DS PrimeTaper EV implant system (Dentsply Sirona, York, PA, USA) incorporates a progressively tapered body with variable thread geometry, designed to improve insertion torque and cutting efficiency, thereby enhancing initial fixation. The increased initial stability that this design promotes may be particularly crucial in challenging bone situations, and to support immediate loading protocols. A recent in vitro study confirmed that, in low-density bone models, the DS PrimeTaper EV exhibited significantly higher insertion torque compared to parallel-walled implants, thereby substantiating its enhanced mechanical coupling to the bone [5].

Alongside primary stability, preservation of peri-implant tissues—particularly marginal bone (MBL)—is a key indicator of clinical success. Several studies have reported that new implant systems demonstrating marginal bone loss of ≤ 0.5 mm at one year may be considered to perform within acceptable clinical thresholds [6–9].

Despite the promising mechanical performance of newer implant systems, early clinical adoption without rigorous scientific validation may pose potential risks to clinical outcomes and patient safety. Therefore, prospective clinical evaluation in real-world private practice settings remains essential for assessing survival rates, clinical success, and the incidence of biological and mechanical complications [10]. In this regard, the separate ongoing "Multicentre Study to Evaluate the Clinical Outcome of PrimeTaper EV Implant in Single-Tooth Restorations" [11] aims to provide additional evidence on the mid-term clinical performance of this implant design (NCT05315414, ClinicalTrials.gov).

This report presents the preliminary findings from a prospective study evaluating the DS PrimeTaper EV system over the short term (mean follow-up 14.9 months; range 4–33 months) in a private practice setting. The full study will extend to a 3-year observation period. The primary objective of the present study is to evaluate the survival and success rates, and radiographic bone loss of DS Prime Taper implants (DS-PT), as well as the occurrence of complications and related clinical variables, and to identify predictive factors of these outcomes. The results of this study are intended to provide practical evidence on the safety, efficacy, and reliability of this novel implant design.

Comparative studies have generally reported higher insertion torque and primary stability for tapered macrodesigns than for cylindrical, parallel-walled implants, particularly in soft bone and in immediate-placement scenarios, although differences in secondary stability and early crestal bone levels tend to equalise after healing [12, 13]. Independent, practice-based evidence on the newer DS PrimeTaper EV design remains limited. We therefore hypothesised that, under everyday private-practice conditions, the DS PrimeTaper EV system would achieve short-term survival and marginal bone-level stability comparable to those reported for established implant systems; as a secondary aim, we sought to identify patient-, site-, and prosthesis-related factors associated with implant failure and marginal bone loss.

Materials and methods

Study design and setting

This observational cohort study is reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement for observational studies; the completed STROBE checklist is provided as a supplementary file.

This study was designed as a prospective observational cohort conducted in two private dental clinics. The investigation was carried out at Clínica Dental Esteve (Alicante, Spain) and Clínica Dental Amigó (Valencia, Spain) and was approved by The Drug Research Ethics Committee of the Hospital General Universitario de Elche, Spain (CEIm HGU-Elche) with number PI 80/2022. The study adhered to the principles of the Declaration of Helsinki and complied with Spanish data protection laws (Organic Law 3/2018). The study was registered on ClinicalTrials.gov (NCT05500755) on August 15, 2022.

Inclusion criteria

All consecutive patients requiring implant treatment at the two participating private practices during the recruitment period received DS PrimeTaper EV implants and were enrolled; no eligible patient was excluded (Fig. 1). Patients were included if they received at least one dental implant of the DS PrimeTaper EV system (Dentsply Sirona, York, PA, USA) (Fig. 2) between August 2022 and January 2025. All patients provided written informed consent prior to inclusion in the study.

Outcome measures

The primary outcome measures were:

- Implant survival rate at 12 months, defined as the implant remaining in situ without removal, regardless of complications.
- Implant success rate, defined as the absence of pain, mobility, infection, or radiographic bone loss exceeding 0.5 mm on either the mesial or distal aspect, assessed at the final available radiographic follow-up. A conservative ≤ 0.5 mm threshold, rather than the historical ≤ 1.5 mm first-year criterion, was adopted to provide a sensitive test of the platform-shifted design's objective of minimising early crestal remodelling; success at the ≤ 1.5 mm threshold is additionally reported as a sensitivity analysis [14, 15].
- Incidence of biological and mechanical complications, classified according to their nature and time of occurrence.

Definitions

- History of periodontitis was defined as the presence of at least four sites with clinical attachment loss of ≥ 3 mm, or a history of periodontal treatment or tooth extraction for periodontal reasons within the year preceding implant placement.
- Bone quantity and quality were evaluated using cone-beam computed tomography (CBCT) imaging and the tactile feedback experienced by the clinician during osteotomy preparation. Classification was based on the criteria established by Lekholm and Zarb [16].

Implants were placed by two experienced surgeons using a single surgical unit (KaVo INTRAsurg 300; KaVo Dental, Biberach, Germany). Osteotomies followed the manufacturer's drilling sequence, applied consistently by both operators under a common written protocol. Motor-driven insertion torque was capped at 40 Ncm; when

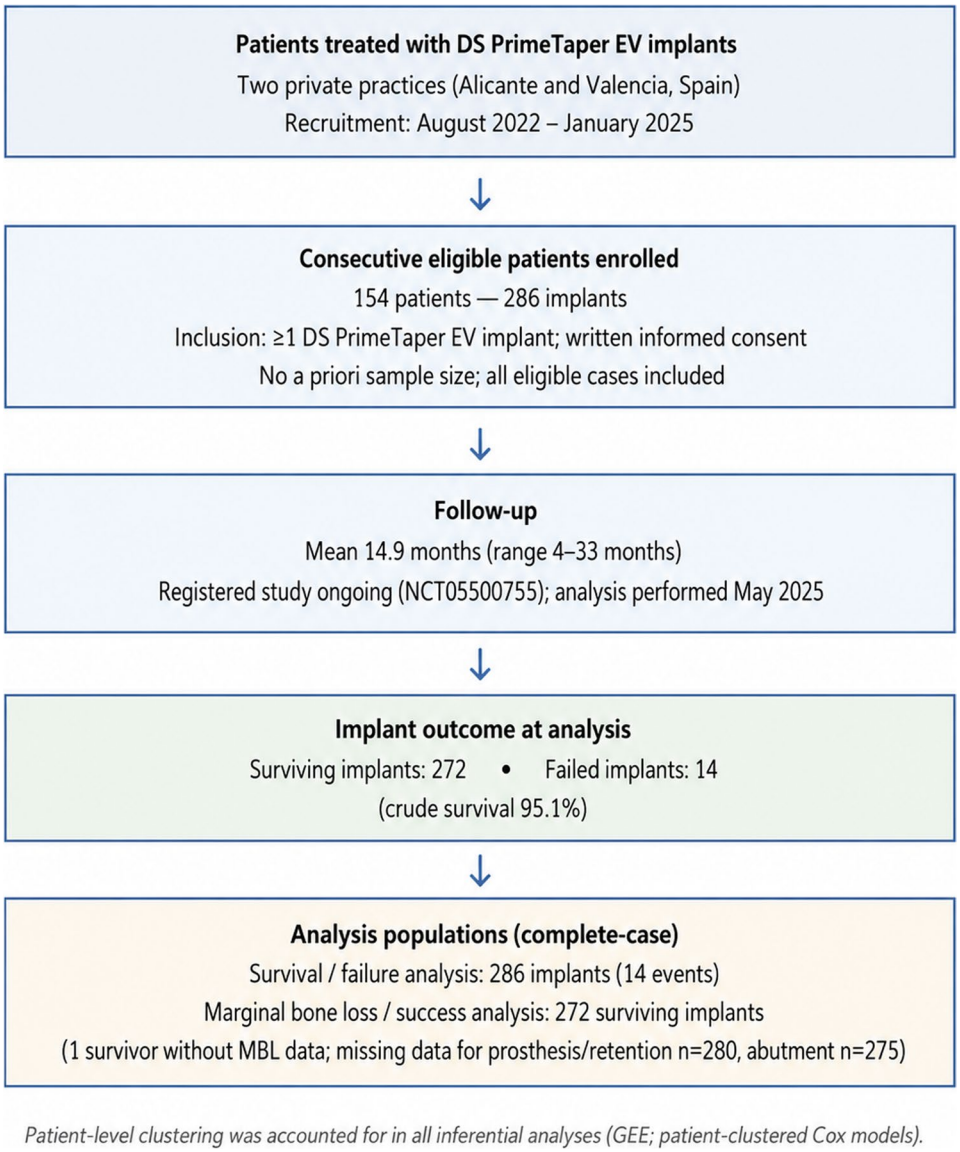


Fig. 1 Participant flow diagram (STROBE). Flow of patients and implants from consecutive enrolment to the analysis populations

greater seating torque was required, it was completed manually with a torque ratchet (manual torque > 40 Ncm). Final insertion torque was recorded for every implant.

- Peri-implantitis was defined according to the criteria of Herrera D. et al. 2023 [17]:
  - Presence of bleeding and/or suppuration on gentle probing.
  - Increased PD compared to previous examinations.
  - Presence of bone loss beyond crestal bone level changes resulting from initial bone remodelling.
- Parafunctional habits were identified on the basis of the patient's self-report of clenching or grinding teeth during sleep or wakefulness, as well as the presence of clinical indicators
  - Visible dentin exposure and wear facets.
  - Hypertrophy of the masticatory muscles.
  - Pre-existing diagnosis and current use of an occlusal splint.

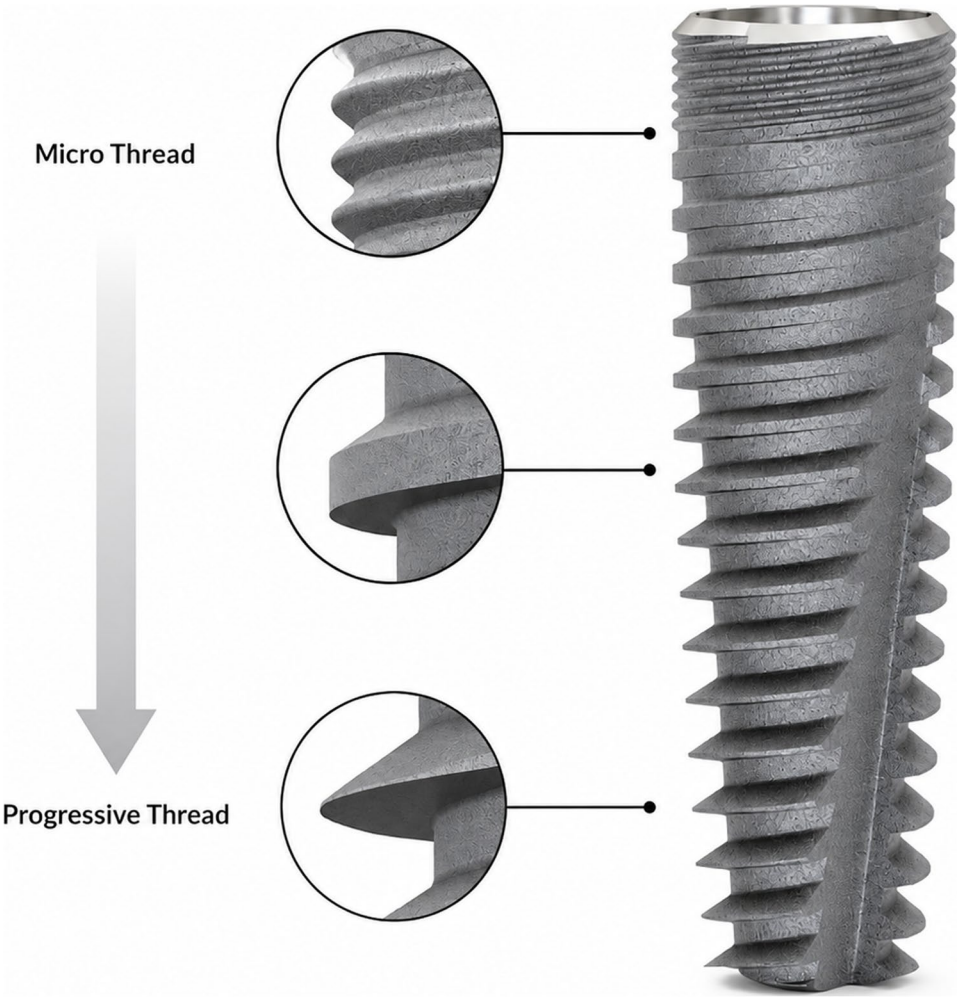


Fig. 2 Macroscopic view of the DS PrimeTaper EV implant. The progressive taper, apical cutting threads, and deep thread design are visible, supporting enhanced primary stability during insertion

Data collection

Clinical data were collected prospectively at each scheduled clinical and radiographic visit and entered into a structured database that had been designed a priori by the principal investigators, in accordance with a predefined study protocol. No retrospective chart review was undertaken. The following variables were collected:

- Patient demographics (age and sex)
- The presence of periodontitis or bruxism and the medical status
- Date of implant placement
- Implant dimensions (diameter and length)
- Location (maxilla or mandible, anterior or posterior region)
- Implant site type (healed bone, post-extraction, post-explantation or with bone grafting)
- The bone volume and density in the implant site
- The Insertion Torque Value (ITV) and Implant Stability Quotient (ISQ) at the time of placement and before the second prosthetic phase
- Type of prosthetic restoration (fixed or removable; single, partial or complete arch implant supported prosthesis; screw-retained or cemented)
- Type of abutment (Atlantis, UniAbutment, MultiBase, Tibase, Locator or Ball)
- Type and timing of loading in months (immediate, or delayed)

- Date of the most recent radiographic control (expressed in months post-placement)
- Biological complications (e.g., inflammation, peri-implant bone loss)
- Mechanical complications (e.g., screw loosening, porcelain fracture, abutment or implant fracture)
- Implant failure or explantation, if applicable
- Interproximal Marginal Bone Loss (MBL) in millimetres, if applicable

Radiographic examination

Bone levels were assessed using digital panoramic or periapical radiographs. To account for early bone remodelling following implant placement, the radiograph taken at the time of surgery served as the baseline reference. Digital images were analysed using Sidexis software (Sirona Dental Systems), and linear measurements were performed by a single examiner (co-author L. Esteve-Colomina), who did not perform the implant surgeries and was blinded to clinical outcomes; as only one examiner was involved, inter-examiner reliability did not apply, and the absence of a formal intra-examiner repeatability coefficient is acknowledged among the study limitations. Measurements extended from the implant shoulder—specifically, the apical border of the bevel—to the most coronal point of bone-to-implant contact on both mesial and distal aspects. Calibration was based on the implants known length and thread pitch as outlined by Esteve-Pardo & Esteve-Colomina [18].

To minimise projection errors in periapical radiographs, only those with symmetrical thread visibility—indicating correct perpendicular beam angulation—were included in the analysis. For panoramic images, magnification was corrected using the actual implant length and the count of visible threads.

To reduce measurement bias, all radiographs were assessed following the same calibration procedure based on implant length and thread pitch. Ambiguous or non-interpretable radiographs were reviewed jointly by the examiner and the principal investigators, and consensus was used only to determine interpretability, not as a repeated-measurement reliability assessment. Uninterpretable images were recorded as a proportion of all radiographs taken, and the corresponding implants were censored accordingly.

Clinical procedures

Prior to surgery, all patients underwent comprehensive clinical and radiographic evaluations. Informed consent was obtained after explaining the proposed treatment and the anticipated prosthetic rehabilitation.

Given the diversity of clinical scenarios included in this study, a variety of procedural approaches were employed. Anaesthetic techniques—including local anaesthesia and sedation—were selected based on individual case requirements. The use of antibiotics, bone grafting techniques, and biomaterials was determined according to specific clinical indications.

Osteotomy preparation and implant placement were conducted in accordance with the manufacturer's guidelines, with adaptations made when necessary to account for differences in bone density or anatomic constraints. All prosthetic procedures were carried out by the authors following a standardised protocol and in close clinical collaboration.

Both immediate and delayed loading strategies were implemented. The definitive restorations included both fixed prostheses —such as single crowns, fixed partial dentures, or full-arch bridges— and removable prostheses, including complete or partial overdentures. Abutment selection was individualised according to the type of restoration planned.

Importantly, all patients received DS PrimeTaper EV implants exclusively. Postoperative follow-up was conducted one month after prosthesis placement. Thereafter, all patients were enrolled in a structured maintenance program with follow-up visits scheduled every six months.

In addition to clinical and radiographic assessments, a standardised patient-reported outcome questionnaire, designed following the numerical rating scale (NRS) format, was administered (Fig. 3). This questionnaire was

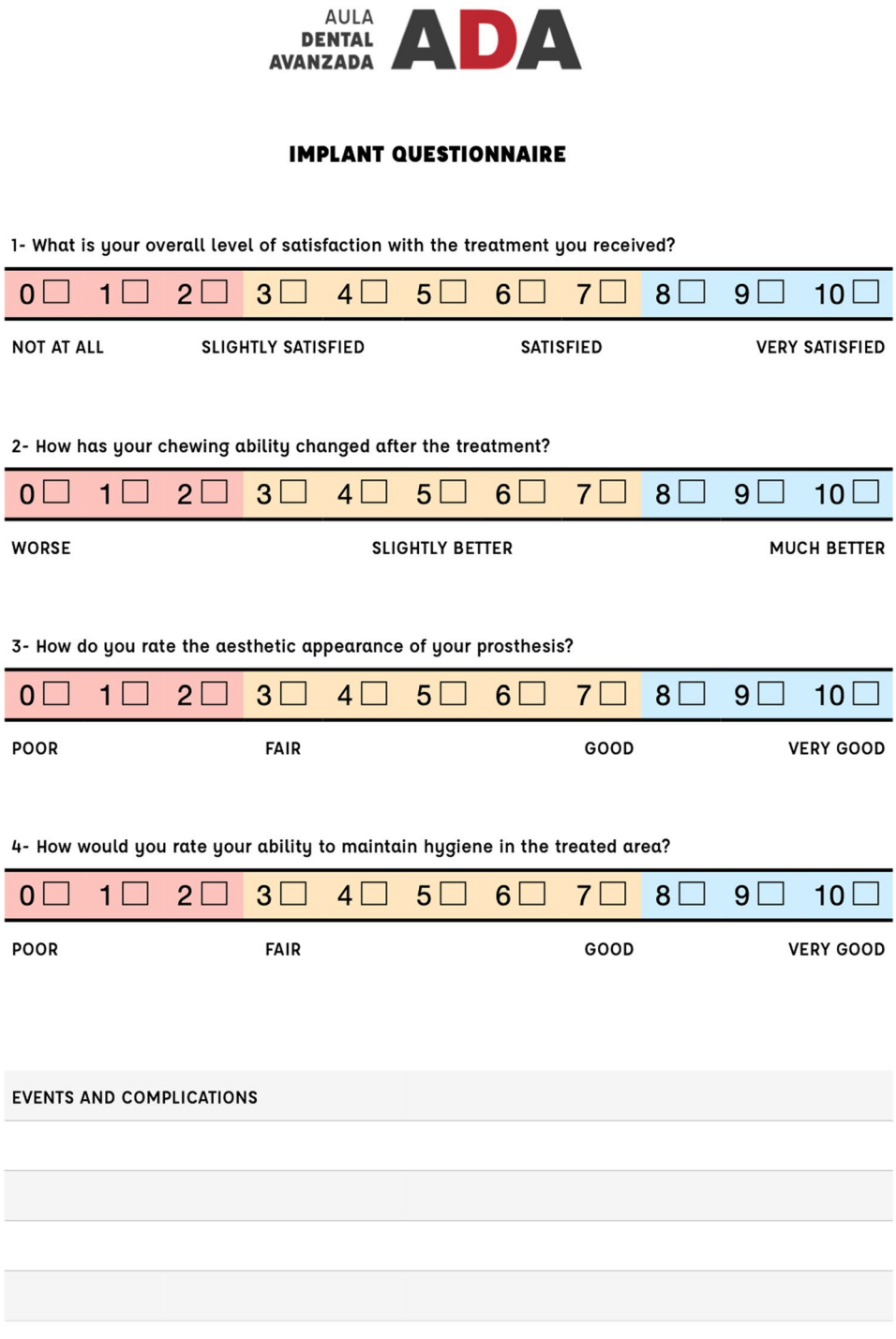


Fig. 3 Patient-reported outcomes questionnaire. Visual representation of the numerical rating scale (NRS) used to evaluate general satisfaction, masticatory function, prosthetic aesthetics, and hygiene maintenance

administered at least six months after delivery of the final prosthesis, ensuring that each patient had functioned with the definitive restoration for a minimum of six months. Accordingly, PROMs were obtained from the subset of patients who had completed at least six months of function with the definitive prosthesis and who attended and completed the questionnaire when contacted (135 of 154 patients); the remaining 19 patients either had not yet reached six months of prosthetic function or did not respond to or attend the recall when contacted. It evaluated patient satisfaction across four key domains: overall treatment experience, perceived improvement in masticatory function, aesthetic evaluation of the final prosthesis, and ease of hygiene maintenance in the treated area.

Responses were collected using structured, graded answer options, providing subjective insight into patient-centred outcomes.

Statistical analysis and handling of correlated data

Descriptive statistics were used to summarise the data. Means and standard deviations (SD), median and quartiles were calculated for continuous variables, while categorical variables were expressed as frequencies and percentages.

The approach of inferential analysis was parametric, given sufficient sample size. Generalised estimating equations (GEE) were used to account for intra-patient clustering: binary logistic GEE regression for the probability of success, and linear GEE regression for marginal bone loss (MBL), based on the independent variables. Factors found to be significant ($p<0.05$) and relevant ($p<0.1$) were included in the final multiple models to obtain adjusted odds ratios and beta coefficients.

Time to implant failure was analysed using a Cox proportional hazards model with robust standard errors clustered by patient to account for intra-patient correlation. Kaplan-Meier survival curves were constructed for descriptive purposes only. Because patients were enrolled across the recruitment period and observation time therefore varied between implants (mean 14.9 months, range 4–33 months), survival at 12 months was estimated using Kaplan–Meier analysis, which accounts for this differential follow-up through censoring. The present analysis was performed in May 2025.

Complication rates were stratified by implant location, dimensions, and type of prosthetic restoration. Statistical analyses were performed using standard software (e.g., SPSS v.25.0, IBM Corp.). No a priori sample size was pre-specified; the study included all consecutive eligible patients treated during the recruitment period. Analyses followed a complete-case approach; missing data were limited (type of prosthesis and retention, $n=280$; type of abutment, $n=275$). No multiple imputation was performed because missingness was limited and variable-specific complete-case denominators were reported.

A post-hoc power analysis showed that, after adjusting for clustering of implants within patients (design effect = 1.45), the effective sample size was 197 implants. For the radiographic success outcome, this provided an estimated power of 86.4% ($\alpha=0.05$) to detect an odds ratio of 2.5 in binary logistic regression—comparable to a difference in success rates of 60% vs. 80%. Power for the rarer implant-failure outcome was substantially lower, which is acknowledged among the limitations.

Missing data were addressed by performing complete-case analyses; implants or patients with unavailable values for a given model were excluded from that specific analysis.

The complete statistical code and output, including generalized estimating equations and Cox regression models, are provided as supplementary materials (Supplementary Files 1–3).

Results

Implant survival

A total of 286 DS PrimeTaper implants were placed in 154 patients, 104 men (67.5%) and 50 women (32.5%) with an overall mean age at the time of intervention of 61.2 ± 11.8 years (Table 1). The mean follow-up time was 14.9 ± 7.2 months (range: 4–33 months) with a median of 15 months (interquartile range 8–20).

The overall crude implant-level survival rate was 95.1% (95% CI: 92.6–97.6%), with 14 implant failures recorded.

The Kaplan–Meier cumulative survival, which accounts for the timing of failures and censoring, was 95.6% at 12 months and 94.3% at the end of follow-up; the difference from the crude rate reflects the contribution of

Table 1 Baseline patient and implant characteristics. Values are presented as absolute numbers and percentages. Variables include demographic information, surgical and prosthetic approaches, and implant distribution by site, diameter, and length

	Characteristic	*n*	%
Age (years)		61.2 ± 11.8	
Number of patients		154	
Gender	Male	104	67.5
	Female	50	32.5
Smoke	Yes	31	20.1
	No	123	79.9
Medical History	Yes	62	40.3
	No	92	59.7
Periodontal Disease	Yes	53	34.4
	No	101	65.6
Bruxism	Yes	66	43.1
	No	87	56.9
Number of implants		286	
Type of placement	Immediate	159	55.6
	Delayed	117	40.9
	After explantation	10	3.5
Guided Surgery	Yes	152	53.1
	No	134	46.9
Type of loading	Immediate	73	25.5
	Delayed	213	74.5
Type of healing	Submerged	102	35.7
	Non-submerged	184	64.3
Type of prosthesis	Single Unit	115	41.1
	Multiple	93	33.2
	Full arch	72	25.7
Type of abutment	Customized	98	35.6
	Stock	157	57.1
	Tibase	14	5.1
	Locator-type	6	2.2
Type of retention	Screwed	271	96.8
	Cemented	9	3.2

Percentages are calculated over the implants with available data for each variable. Denominators below 286 reflect missing data: type of prosthesis and type of retention, $n = 280$; type of abutment, $n = 275$

censored observations. Patient-clustered Cox models with robust standard errors were used to estimate hazard ratios for individual risk factors, which are reported in the failure-analysis section below.

Most failures occurred within the first six months after placement (see the failure analysis below). Descriptive Kaplan–Meier survival estimates showed a mean survival time of 31.5 months (SE = 0.39; 95% CI: 30.7–32.3) over a maximum observation period of 33 months (Fig. 4; Table 2).

Analysis of implant failures

Out of 286 implants placed, 14 failed, resulting in a cumulative implant-level failure rate of 4.9% and a patient-level failure rate of 9.1%. The overall survival rate was 95.1% (95% CI: 92.6–97.6%). Of the 14 failures, 10 (71.4%) occurred within the first six months after placement and 4 (28.6%) occurred thereafter.

Descriptive analysis showed a higher failure rate in premolar sites (10.2%) compared to anterior (3.6%) and molar positions (1.5%) ($p = 0.026$). Immediate implant placement showed a numerically higher failure rate (6.3%) than delayed placement (1.7%); however, placement type was not a significant predictor of failure in the Cox model (delayed vs. immediate: HR = 0.85, 95% CI 0.57–1.28; $p = 0.431$); this pattern was largely attributable to operator, as failures among immediate placements were concentrated in one surgeon (13.4% vs. 1.1%). In

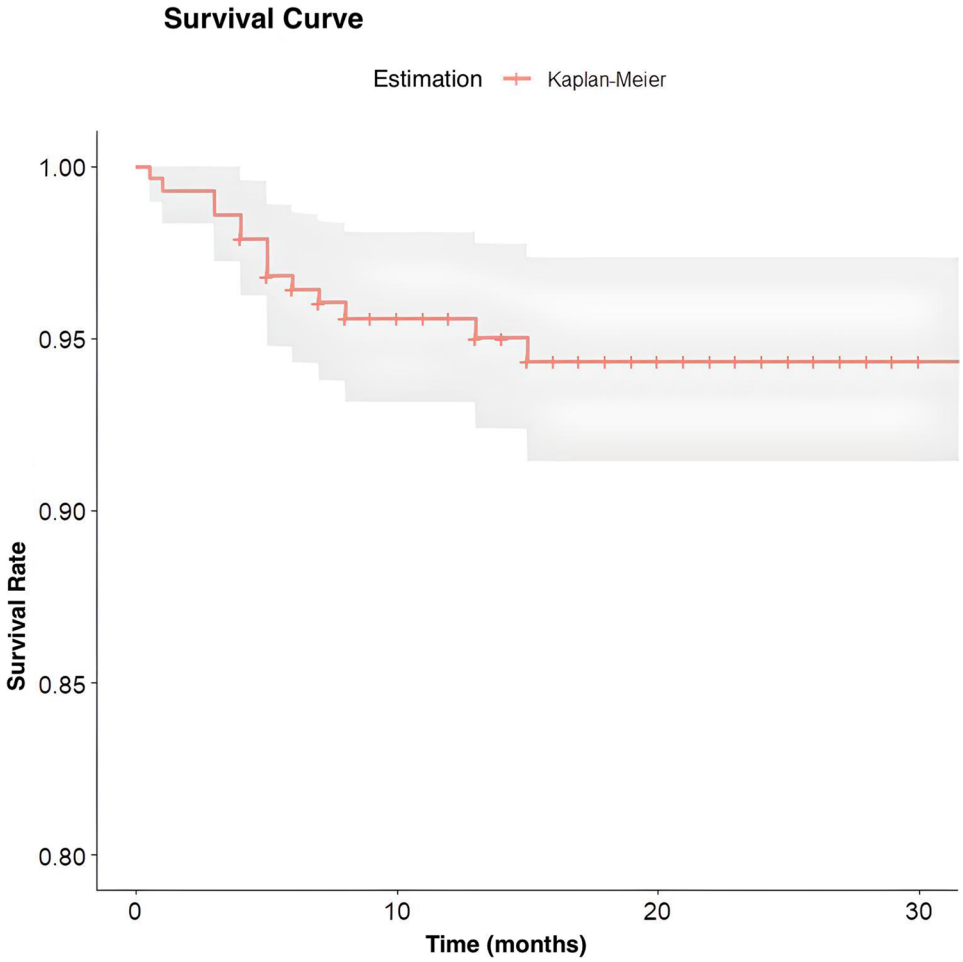


Fig. 4 Kaplan–Meier survival curve for 286 DS PrimeTaper implants over a 33-month follow-up period. Most failures occurred within the first 6 months. Mean survival time was 31.5 months (95% CI: 30.7–32.3)

Table 2 Kaplan–Meier survival estimates for implant failure over time. The table reports the number of implants at risk, failures, censored cases, interval survival, and cumulative survival rates at each time point

Time Interval (months)	At risk	Failures	Censored	Interval Survival	Cumulative Survival
0–3	286	4	0	98.6%	98.6%
3–6	282	6	35	97.9%	96.4%
6–9	241	2	43	99.2%	95.6%
9–12	196	0	29	100%	95.6%
12–24	167	2	129	98.8%	94.3%
24–33	36	0	36	100%	94.3%

addition, implants placed in previously explanted sites demonstrated a failure rate of 20%. Submerged implants presented a higher failure rate (9.8%) than non-submerged implants (2.2%) ($p=0.007$). Moreover, adverse healing events, particularly purulent complications (fistula or abscess), were associated with significantly increased failure (100% failure rate in these cases; $p<0.001$). These descriptive outcomes are summarised in Table 3.

Cox univariate regression analysis identified several factors significantly associated with shorter implant survival, including female sex (HR = 4.87; 95% CI: 1.61–14.8; $p=0.005$), narrow implant diameter (HR = 0.09; 95% CI: 0.01–0.59; $p=0.012$), submerged healing (HR = 4.29; 95% CI: 1.39–13.3; $p=0.012$), cemented prosthetic retention (HR = 9.63; 95% CI: 1.40–66.2; $p=0.021$), and adverse soft-tissue symptoms at the surgical site (HR = 24.7; 95% CI: 7.08–86.5; $p<0.001$).

Table 3 Distribution of implant failures by timing, position, placement type, healing strategy, and healing complications. Early failures were defined as those occurring within the first six months after implant placement, and late failures as those occurring thereafter. Significant associations are marked. *$p < .05$; **$p < .01$; ***$p < .001$

	Total	Failure rate (%)	*p*-value
N of implants	$n = 14$	4.9	
TYPE OF FAILURE			
Early	10	3.5	
Late	4	1.4	
POSITION			
Anterior	2	3.6	
Premolar	10	10.2	0.026*
Molar	2	1.5	
IMMEDIATE PLACEMENT			
Immediate	10	6.3	
Delayed	2	1.7	
Explantation	2	20	
SUBMERGED HEALING			
Yes	10	9.8	0.007**
No	4	2.2	
HEALING EVENTS			<0.001***
None	9	3.2	
Pain	2	50	
Fistula/abscess	3	100	

Placement type was not a significant predictor of failure in the Cox model (HR = 0.85, $p = 0.431$; robust standard errors clustered by patient, as in all survival analyses). The higher crude failure rate among immediate placements was largely attributable to a single operator (see text), not to the placement technique itself

In the multivariate Cox regression model, only female sex (HR = 8.15; 95% CI: 1.74–38.1; $p = 0.008$) and cemented retention (HR = 11.5; 95% CI: 3.59–37.1; $p < 0.001$) remained as significant independent predictors of failure (Table 4).

No statistically significant differences in primary or secondary stability (insertion torque or ISQ values) were observed between failed and successful implants. Similarly, no significant associations were found with guided surgery or implant placement type (immediate versus delayed) after adjustment.

Of the 14 failed implants, 10 were submerged. Five failures were due to poor initial osseointegration (two of which were immediately loaded), and six failures were linked to pre-existing site infections, with three cases evolving into retrograde peri-implantitis.

These findings point to an association between biological factors and prosthetic design decisions, particularly cemented restorations, and implant survival; given the small number of failures these associations are exploratory. Moreover, the higher hazard in female patients suggests a potential role of patient-specific biological or biomechanical factors, meriting further investigation.

Marginal bone loss and success criteria

The mean marginal bone loss (MBL) was 0.15 ± 0.39 mm, with no differences between the measurement sides, and the annualised rate was 0.14 ± 0.33 mm/year (Fig. 5).

Analyses of marginal bone loss were restricted to the 272 surviving implants. At the final radiographic follow-up, the distribution of MBL was as follows:

- MBL = 0 mm: $n = 210$ (77.2%).
- MBL > 0 and ≤ 0.5 mm (mesial and/or distal): $n = 12$ (4.4%).
- MBL > 0.5 mm (mesial and/or distal): $n = 50$ (18.4%).

Table 4 Multivariate Cox regression analysis for time to implant failure (clustered data by patient). Adjusted hazard ratios (HR), 95% confidence intervals (CI), and p-values are presented for the variables retained in the final model after stepwise selection. Female sex and cemented retention emerged as independent predictors of earlier implant failure. A significance level of $p < 0.05$ was considered statistically significant

	HR	95% CI	*p*-value
GENDER			
Male	1		
Female	8.15	1.74–38.1	**0.008****
DIAMETER	0.54	0.09–3.30	0.508
SUBMERGED HEALING			
No	1		
Yes	2.44	0.49–12.2	0.279
HEALING EVENTS			
No	1		
Yes	NE	0.59–45.2	0.137
TYPE OF RETENTION			
Screw	1		
Cement	11.5	3.59–37.1	**<0.001*****

NE, not reliably estimable: with only five failures among the nine implants that presented an adverse healing event, and the resulting near-complete separation, the hazard ratio for this term could not be reliably estimated; the 95% confidence interval and p-value indicate a non-significant association

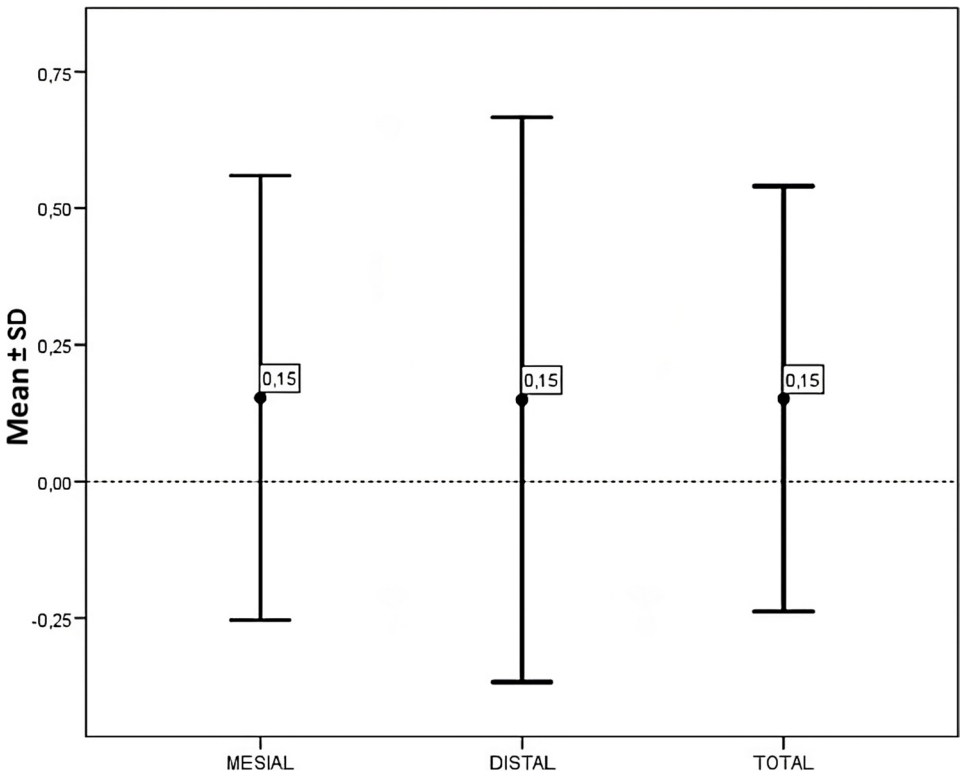


Fig. 5 Marginal bone loss (MBL) at final follow-up. Histogram showing distribution of mean interproximal MBL across the cohort. The majority of implants presented no detectable bone loss or values ≤ 0.5 mm

Applying the predefined success criterion (MBL ≤ 0.5 mm on both the mesial and distal aspects in surviving implants), 222 of the 272 surviving implants were classified as successful, yielding a success rate of 81.6% (95% CI: 77.0–86.2%). Survival and mean marginal bone loss stratified by anatomical region are presented in Supplementary Table S1: survival was 96.7% in the anterior maxilla (1/30 failures), 95.6% in the posterior maxilla (6/135), 96.2% in the anterior mandible (1/26) and 93.7% in the posterior mandible (6/95), with mean marginal bone loss ranging from 0.12 to 0.26 mm across regions.

Sensitivity analyses

The success rate increased to 95.6% when the conventional ≤ 1.5 mm MBL threshold was applied. When only failures occurring after prosthetic delivery were considered, survival was 97.6%, compared with 95.1% for all-cause implant failure. Because failures were concentrated in one operator's caseload, adjusted models including operator were unstable and were interpreted as exploratory.

The multivariable (adjusted) GEE model yielded the following associations with MBL; in this adjusted model only ISQ2 remained statistically significant:

- Implant placement: delayed placement showed a trend towards more MBL than immediate post-extraction placement (β = 0.112, $p = 0.076$).
- ISQ2: higher ISQ2 remained significantly protective against MBL in the adjusted model (β = -0.010, $p = 0.017$*). In univariate analysis, a larger ISQ2–ISQ1 increase was also associated with reduced MBL (β = -0.007, $p = 0.002$**).
- Cemented retention: showed a trend towards greater MBL compared with screw-retained prostheses (β = 0.212, $p = 0.057$).
- With regard to implant sites exhibiting a B or C anatomical configuration, augmentation was performed exclusively by simultaneous guided bone regeneration using granular deproteinized bovine bone mineral (Bio-Oss; Geistlich Pharma) with a resorbable collagen membrane (Collagen AT), with no allograft or synthetic substitutes used, and no statistically significant variations were observed in the outcomes of GBR application. The proportion of implants exhibiting MBL > 0.5 mm in the cohort undergoing GBR treatment or not was found to be equivalent (OR = 1.74; $p = 0.392$).

Incidence and classification of complications

Three biological complications were recorded. Two implants in the same patient, supporting a screw-retained full-arch prosthesis on abutments, developed buccal bone loss associated with inflammation and suppuration, consistent with a diagnosis of peri-implantitis. The third case involved a single-unit restoration that presented marginal bone loss of unclear aetiology, likely caused by prosthetic overpressure in the buccal aspect, without clinical signs of peri-implant disease.

One mechanical complication was also observed: a lithium disilicate single crown fractured one year after prosthesis delivery.

Risk factor analysis

Because implant failure events were few ($n = 14$), failure-related predictors were interpreted primarily from the Cox models described above. GEE logistic regression was then used to explore factors associated with the predefined implant success outcome among surviving implants, defined as absence of pain, mobility, infection, or MBL > 0.5 mm. In univariate GEE analyses:

- Bruxism was associated with higher odds of success: OR = 2.15 (1.02–4.53), $p = 0.045$*.
- Greater success was found in mandibular sites: OR = 2.11 (1.01–4.41), $p = 0.048$*.
- Higher ISQ2 values correlated with higher odds of success: OR = 1.08 per unit increase (1.02–1.15), $p = 0.008$**.
- Time to prosthetic loading was inversely correlated with success: OR = 0.88 per additional month (0.79–0.98), $p = 0.020$*.
- Cemented retention showed a trend towards lower success: OR = 0.29 (0.08–1.02), $p = 0.054$.
- Early detection of MBL was strongly associated with lower odds of final success: OR = 0.09 (0.04–0.21), $p < 0.001$***.

In the multivariable GEE model, longer time to prosthetic loading, cemented retention, and early MBL detection remained associated with lower odds of achieving the predefined success criterion.

Patient-reported outcomes (PROMs)

Patient satisfaction was evaluated through a questionnaire administered at least six months after delivery of the final prosthesis and completed by 135 of the 154 patients. The mean scores on a 1-to-10 scale were as follows (Fig. 6):

- Perception of ease of hygiene: 9.0 ± 1.2
- Improved chewing ability (function): 9.3 ± 1.0
- Aesthetic aspect: 9.4 ± 1.0
- Overall satisfaction: 9.4 ± 1.0

When questionnaire results were analysed according patient and implant characteristics, various findings were to be highlighted:

- Patients diagnosed with periodontal disease demonstrated a reduced level of satisfaction across all domains of the PROMS.
- Delayed implants exhibited a tendency for diminished overall satisfaction ($p = 0.072$) and aesthetics ($p = 0.067$) in comparison to immediate implants.
- With the exception of ease of hygiene, satisfaction was higher for immediately loaded implants.
- As the ITV increases, so too does the level of satisfaction related to mastication ($p = 0.042$*) (Fig. 7).

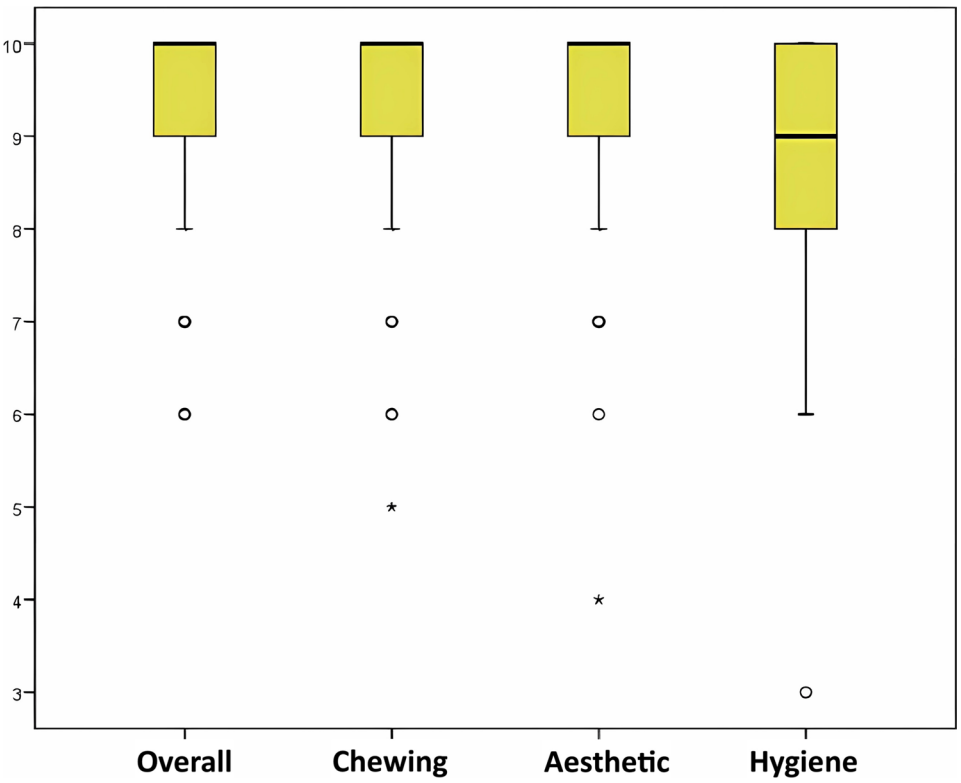


Fig. 6 Patient-reported outcomes (PROMs). Mean scores on a 10-point scale across four domains: overall satisfaction, functional improvement, aesthetics, and perceived hygiene. All values indicate high satisfaction

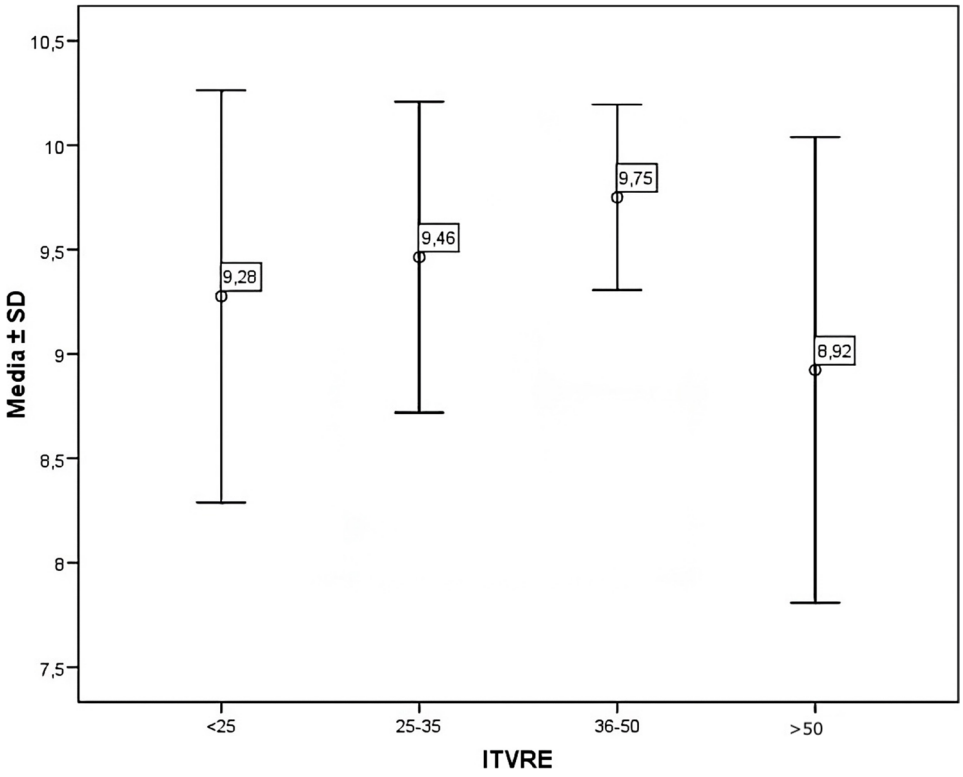


Fig. 7 Relationship between patient satisfaction and insertion torque (ITV). Higher ITV values were associated with increased satisfaction in masticatory function. The trend plateaued at ITV > 50 Ncm

Discussion

This prospective observational study provides preliminary clinical, radiographic, and patient-centred outcomes for DS PrimeTaper EV implants over short-term follow-up (mean 14.9 months; range 4–33 months) in a real-world private practice setting. A total of 286 implants were evaluated with respect to survival, failure timing, marginal bone loss (MBL), complications, and patient-reported outcomes (PROMs). While the full study duration is designed to be three years, these early results offer valuable insights into the short-term performance of this novel implant design and inform directions for future research.

Principal findings

The crude overall survival rate was 95.1% (272/286; 95% CI: 92.6–97.6%), with 14 total failures, of which 10 (71.4%) occurred within the first six months after placement and 4 (28.6%) thereafter. The corresponding Kaplan–Meier estimate of survival at 12 months was 95.6%, declining to 94.3% by the end of follow-up. This survival rate aligns with the range reported for modern implant systems in similar timeframes [18–22].

Failure patterns

The majority of such failures can be categorised as early, since they occurred within the first six months after implant placement. The extant literature indicates that the incidence of early failures is approximately twice that of late failures [23]. In the present study, early failures (those occurring within the first six months after placement) accounted for 71.4% of all failures. Most of these were submerged and failures recorded at implant exposure, in the days following loading, or when the temporary prosthesis was replaced by the permanent one. This timing suggests a lack of sufficient initial osseointegration resulting in mobility when the implants were subjected to prosthetic connection. This finding indicates a critical period of vulnerability for osseointegration induced by

prosthetic procedures [24, 25]. Indeed, prosthetic procedures involve the application of a functional load to the implants, which may exceed the bone's ability to withstand such forces.

In addition, surgical factors such as drill wear and heat generation during osteotomy preparation can influence osseointegration outcomes. A recent study using DS PrimeTaper implants demonstrated a strong correlation between drill wear and increased intraosseous temperature during implant bed preparation, underscoring the importance of optimising surgical protocols and drill design to reduce biohazards [26].

Interestingly, failure distribution was highly skewed by operator, with 13 of the 14 failures attributed to one of the two surgeons involved. This crude between-operator difference was statistically significant (8.0% vs. 0.8%; $p < 0.01$); because of the near-complete separation, with 13 of the 14 failures concentrated in one operator's caseload, operator could not be reliably incorporated as a covariate in the multivariable models, and this confounding should be kept in mind when interpreting the risk-factor associations. This finding nonetheless pointed to the potential influence of surgical technique, learning curve, or case selection. This point has already been made in an extensive retrospective study [27].

The inter-arch differences in failures in the present study obtained a non-significant p value of 0.447. This finding aligns with the results reported in several studies [23, 25] but contradicts other studies [28–31]. This discrepancy suggests that other multiple factors such as bone quality, surgical technique, and patient-specific variables often play a more critical role than jaw location alone. In the present study, implants in premolar locations showed the highest failure rate.

Implant failure and primary stability

No statistically significant differences were observed between ITV and ISQ values in successful and failed implants, indicating a limited ability of primary stability to predict the possibility of early failure [32]. However, a downward trend in the mean ITV at failures was observed, which is consistent with the hypothesis that an ITV cutoff of 30 Ncm remains critical for initial and early osseointegration [20], particularly when immediate loading is applied [33]. It has been shown that tapered implants obtained higher primary stability than parallel walled implants [34]. This conclusion was already demonstrated in vitro for DS-PT system [5]. On the other hand, it was recommended that ITV should not reach excessively high values. In the present study, the DS-PT macrogeometry achieved a good initial stabilisation equation with an ISQ1 of 69.3 ± 11.8 and a relatively low global mean ITV of 28.4 ± 12.6 Ncm. It appears that implants placed within a moderate torque range may provide optimal results, as evidenced by a recent study in which implants placed at lower torques had higher ISQ values [35, 36]. All this seems to support the concept of viable constraint; described by Norton [37], whereby adequate mechanical engagement is achieved without inducing excessive compressive stress that could lead to early bone necrosis or increased remodelling [19, 38].

Risk factors and prognostic indicators

Clinical analysis provided additional evidence. Infection has been identified as a major factor in early implant failure [39]. In our sample, six failures were associated with pre-placement infections, and three of these developed retrograde peri-implantitis. The presence of adverse symptoms during the healing process was found to be associated with a reduced time to failure ($p < 0.001$). These data highlight the key role of early biological events, infection control, and site-specific risks in implant prognosis.

The implant- and site-specific risk factors identified in the study are consistent with those described in the literature. These include submerged (two-stage) healing, implant insertion in fresh extraction sockets, immediate loading and smaller-diameter implants. The higher failure rate observed with submerged healing (9.8% vs. 2.2%) should, however, be interpreted with caution and may reflect confounding by indication, as a submerged, two-stage approach was preferentially selected in more demanding situations (immediate placement, grafted or compromised sites); consistent with this, submerged healing did not remain significant in the multivariable model

[40, 41]. Despite the absence of differences in survival rates for implant diameter observed in the literature [23, 25, 42], the present study has yielded statistically significant results. While it can be hypothesised that narrow-diameter implants may demonstrate reduced stability, the data supporting this claim should be of limited evidential value, primarily due to the limited number of cases reported.

Among patient-specific factors, female sex was associated with shorter implant survival in the Cox model. However, this finding should be interpreted with caution because only 14 failures occurred and 13 of them were concentrated within one operator's caseload, making the estimate vulnerable to imbalance and overfitting. Smoking, periodontal disease, and bruxism were not clearly associated with implant failure in the present cohort.

Complications

Although the incidence of biological and mechanical complications was low, these events provided valuable insights. Two cases of peri-implantitis were detected in a patient with a full-arch prosthesis, highlighting the susceptibility of extensive restorations to biological complications. An additional case of non-infectious buccal bone loss likely related to prosthetic overpressure reinforces the importance of prosthetic design in maintaining peri-implant bone. A single mechanical complication—a fractured lithium disilicate crown—illustrates the need for cautious material selection in single-unit restorations. While isolated, such findings underscore the necessity of close clinical monitoring and individualised maintenance protocols.

Marginal bone loss

Marginal bone loss was minimal overall, with a mean annual MBL of 0.14 ± 0.33 mm. Among the surviving implants, 77.2% showed no detectable bone loss and 81.6% met the predefined success threshold of MBL ≤ 0.5 mm, whereas 18.4% exceeded it. The results are in agreement with investigations of the predecessor implant with the same surface and prosthetic connection [18].

A factor not captured in the present analysis is the prosthetic emergence angle (EA) and crestal contour. In bone-level implants, a steep EA (> 30°) has been associated with a higher prevalence of peri-implantitis, with the prevalence approximately doubling and rising further when a convex profile is combined with a steep angle [43, 44]. However, the most recent meta-analysis found no significant overall effect of EA on marginal bone level, a significant difference emerging only in platform-matched implants [45]. As the DS PrimeTaper EV uses a platform-switched conical connection, this evidence suggests that any influence of emergence angle on the marginal bone-level changes observed here is likely attenuated; the single case of buccal bone loss attributed to prosthetic overpressure in our cohort is nonetheless consistent with this mechanism. Emergence angle and contour were not recorded in this cohort and could not be evaluated as covariates; this is acknowledged as a limitation, and their prospective measurement is planned in the continued follow-up of the registered study.

ISQ values exhibited a tendency to rise between the two measurements. According to the GEE simple model, the greater this increase, the more attenuated the MBL appears ($p = 0.002$). It is noteworthy that ISQ2 values, obtained prior to the prosthetic phase, were found to be highly significant. The study revealed that each additional unit of this parameter increased by 8% (OR = 1.08; $p = 0.008$) the odds of success, defined as implants without symptoms or complications exhibiting an MBL < 0.5 mm. This finding underscores the significance of ISQ values in the assessment of osseointegration.

The application of MBL analysis to ridges exhibiting an anatomical shape of B or C, with respect to whether GBR had been performed, revealed no significant differences. This result is not consistent with the findings of some author [25], but coincides with those of other authors [28, 46]. The observed incongruity may be attributable to inhomogeneities within the research processes.

Patient-reported outcomes

The PROMS study demonstrated high satisfaction levels across all domains, including comfort, function, aesthetics, and overall experience, with mean scores ranging from 9 to 9.4 out of 10. These favourable subjective results are indicative of the patient perceived success of the treatment, even in cases involving partial or full-arch prostheses. This positive performance of PROMs is in line with the findings of earlier studies showing that aesthetic and functional outcomes are key determinants of patient satisfaction [47, 48]. These outcomes frequently stand apart from radiographic success metrics. Further correlation between clinical outcomes and PROMS will be necessary to substantiate these observations.

Slight discrepancies were identified among patients diagnosed with periodontal disease, exhibiting diminished levels of satisfaction across all domains of the PROMS. It could be due to the associated symptomatology of their condition. With the exception of ease of hygiene, PROMS scores were marginally higher in immediate loading cases, as would be expected given the restoration's immediate availability.

It is noteworthy that as the ITV increases, so does the level of satisfaction derived from mastication ($p = 0.042$). This association may reflect the greater functional confidence afforded by higher primary stability, although it is exploratory. This trend appeared to level off above 50 Ncm, which may be related to the effects of excessive torque on the peri-implant bone.

Strengths and limitations

One of this study's main strengths lies in its prospective design, well-defined inclusion criteria, and realistic clinical setting, which involves two operators and a wide range of treatments and clinical situations. This serves to reinforce its external validity, thereby providing realistic estimates of implant performance under typical use conditions. Moreover, the intra-patient correlation due to multiple implants per patient was appropriately handled through the application of generalized estimating equations (GEE) and Cox regression models with robust standard errors.

However, certain limitations should be acknowledged. The short-term follow-up (mean 14.9 months; range 4–33 months) is insufficient to evaluate long-term risks, including peri-implantitis, prosthetic complications, or mechanical fatigue. As the implant's life is prolonged, an increase in the incidence of complications has been observed [49, 50]. Missing ISQ2 data, particularly in one operator group, reduced the sample size available for multivariable analyses and may have limited the precision of the estimates. With regard to PROMS, the absence of a validated questionnaire diminishes the comparative value of the results. Finally, the absence of a control arm using a different implant macrodesign precludes direct attribution of the outcomes solely to the PrimeTaper geometry. In addition, with only 14 failures the multivariable models are vulnerable to overfitting, and 13 of these 14 failures occurred within a single operator's caseload (8.0% versus 0.8%); the associations observed for individual risk factors should therefore be regarded as hypothesis-generating rather than confirmatory.

Clinical implications and future research

The preliminary short-term results of the present study are consistent with reliable short-term performance of the DS PrimeTaper EV implant system when placed under standard protocols, with high survival, minimal marginal bone loss, and a favourable primary-stability profile. Given the single-arm design and short follow-up, and the concentration of failures within a single operator, these findings should be interpreted as preliminary.

However, it was found that certain clinical variables were associated with an increased risk of failure. This highlights the need for careful case selection and adherence to evidence-based protocols.

The study is planned to continue with three- and five-year follow-up assessments. Ongoing studies over longer timeframes will be essential to validate these early outcomes and to guide optimal use of the DS Prime Taper implant system in diverse clinical scenarios. To fully characterise the clinical performance of this implant system,

patient-centred outcomes must be included. Additionally, controlled comparative trials involving implants with different geometries will be useful to isolate the influence of macro design on success metrics.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1186/s12903-026-10414-2.

Acknowledgements The authors would like to thank Juan Luis Gómez Martínez for his collaboration in the statistical analysis of this study.

Authors' contributions GE-P: conceptualization, methodology, clinical investigation, data curation, formal analysis, writing – original draft. JA-B: clinical investigation, data collection, writing – review and editing. LE-C: radiographic data acquisition, radiographic measurements, data interpretation, writing – review and editing. All authors read and approved the final manuscript and agreed to be accountable for all aspects of the work.

Funding This study was funded by Dentsply Sirona. The funder had no role in the study design, patient selection, clinical procedures, data collection, data analysis, interpretation of the results, writing of the manuscript, or the decision to submit the article for publication.

Data availability The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate The study was approved by the Drug Research Ethics Committee of the Hospital General Universitario de Elche, Spain (CEIm HGU-Elche; reference number PI 80/2022). All participants provided written informed consent prior to inclusion. This study was conducted in accordance with the Declaration of Helsinki.

Consent for publication Not applicable.

Competing interests The authors declare no personal financial competing interests. This study received funding/support from Dentsply Sirona. The funder had no role in the study design, patient selection, clinical procedures, data collection, data analysis, interpretation of the results, writing of the manuscript, or the decision to submit the article for publication.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

1. Meredith N. Assessment of implant stability as a prognostic determinant. Int J Prosthodont. 1998;11(5):491–501. PMID: 9922740.
2. Alghamdi HS, Jansen JA. The development and future of dental implants. Dent Mater J. 2020;39(2):167–72. https://doi.org/10.4012/dmj.2019-140.
3. Heimes D, Becker P, Pabst A, et al. How does dental implant macrogeometry affect primary implant stability? A narrative review. Int J Implant Dent. 2023;9(1):20. https://doi.org/10.1186/s40729-023-00485-z.
4. Ayub FA, Dewi RS. Optimizing Implant Macro-geometry to Improve Primary Stability in Low Bone Density: A Systematic Review. J Indones Dent Assoc. 2024;7(2):49–55. https://doi.org/10.32793/jida.v7i2.1280.
5. Degidi M, Daprile G. Primary Stability Evaluation of a Novel Tapered Implant Inserted in Low-Density Bone Sites: An In Vitro Study. Int J Oral Maxillofac Implants. 2023;38(2):334–7. https://doi.org/10.11607/jomi.9967.
6. Zwaan J, Vanden Bogaerde L, Sahlin H, Sennerby L. A One-year Follow-up Study of a Tapered Hydrophilic Implant Design Using Various Placement Protocols in the Maxilla. Open Dent J. 2016;10:680–91. https://doi.org/10.2174/1874210601610010680.

7. Fügl A, Zechner W, Pozzi A, et al. An open prospective single cohort multicenter study evaluating the novel, tapered, conical connection implants supporting single crowns in the anterior and premolar maxilla: interim 1-year results. Clin Oral Investig. 2017;21(6):2133–42. https://doi.org/10.1007/s00784-016-2003-0.
8. Cardaropoli D, Tamagnone L, Roffredo A, De Maria A. Clinical and Radiologic Evaluation of a Fully Tapered Implant with Immediate Placement in the Esthetic Zone: A Prospective Case Series Study. Int J Periodontics Restor Dent. 2022;42(5):631–7. https://doi.org/10.11607/prd.5682.
9. Henao PAR, Queija LC, Linder S, Dard M, González AL, Carrión JB Clinical and Radiographic Outcomes of a New Fully Tapered Implant with the One-Abutment One-Time Approach: In-Line Clinical Case Series with a 1-Year Follow-up. Int J Oral Maxillofac Implants. 2023;17(5):943–53. https://doi.org/10.11607/jomi.10276.
10. Block MS. What Factors May Influence a Clinician's Choice for an Implant System for Their Patients? J Oral Maxillofac Surg. 2024;82(9):1088–99. https://doi.org/10.1016/j.joms.2024.05.010.
11. ClinicalTrials.gov. Multicentre Study to Evaluate the Clinical Outcome of PrimeTaper EV Implant in Single-Tooth Restorations. Identifier: NCT05315414. https://clinicaltrials.gov/study/NCT05315414. Accessed 11 June 2026.
12. Nandini N, Kunusoth R, Alwala AM, Prakash R, Sampreethi S, Katkuri S. Cylindrical implant versus tapered implant: a comparative study. Cureus. 2022;14(9):e29675.
13. Kielbassa AM, Martínez-de Fuentes R, Goldstein M, et al. Randomized controlled trial comparing a variable-thread novel tapered and a standard tapered implant: interim one-year results. J Prosthet Dent. 2009;101(5):293–305.
14. Galindo-Moreno P, León-Cano A, Ortega-Oller I, Monje A, O Valle F, Catena A. Marginal bone loss as success criterion in implant dentistry: beyond 2 mm. Clin Oral Implants Res. 2015;26(4):e28–34. https://doi.org/10.1111/clr.12324.
15. Galindo-Moreno P, Catena A, Pérez-Sayáns M, Fernández-Barbero JE, O'Valle F, Padial-Molina M. Early marginal bone loss around dental implants to define success in implant dentistry: A retrospective study. Clin Implant Dent Relat Res. 2022;24(5):630–42. https://doi.org/10.1111/cid.13122.
16. Lekholm U, Zarb GA. Patient selection and preparation. In: Branemark PI, Zarb GA, Albrektsson T, editors. Tissue-integrated Prostheses: Osseointegration in Clinical Dentistry. Chicago: Quintessence; 1985. pp. 199–209.
17. Herrera D, Berglundh T, Schwarz F, et al. Prevention and treatment of peri-implant diseases-The EFP S3 level clinical practice guideline. J Clin Periodontol. 2023;50(Suppl 26):4–76. https://doi.org/10.1111/jcpe.13823.
18. Esteve-Pardo G, Esteve-Colomina L. Clinical and Radiographic Evaluation of OsseoSpeed EV Implants. Int J Oral Maxillofac Implants. 2023;17(5):963–75. https://doi.org/10.11607/jomi.10258.
19. Toia M, Stocchero M, Cecchinato F, Corrà E, Jimbo R, Cecchinato D. Clinical Considerations of Adapted Drilling Protocol by Bone Quality Perception. Int J Oral Maxillofac Implants. 2017;32(6):1288–95. https://doi.org/10.11607/jomi.5881.
20. Carr BR, Jeon-Slaughter H, Neal TW, Gulko JA, Kolar NC, Finn RA. Low Insertional Torque and Early Dental Implant Failure. J Oral Maxillofac Surg. 2022;80(6):1069–77. https://doi.org/10.1016/j.joms.2022.02.001.
21. Kowar J, Lund H, Stenport VF. Long-term performance of implants with moderately rough anodized surface supporting single-tooth restorations: A retrospective analysis with an up to 15-year follow-up. Clin Oral Implants Res. 2023;34(4):367–77. https://doi.org/10.1111/clr.14048.
22. Song YW, Yoo SH, Park JY, et al. Long-term clinical and radiographic outcomes of a bone-level, 2-piece, internal connection implant system with coronal microthreads over 10 years of follow-up: a retrospective clinical study. J Periodontal Implant Sci Published online November. 2024;13. https://doi.org/10.5051/jpis.2401100055.
23. Staedt H, Rossa M, Lehmann KM, Al-Nawas B, Kämmerer PW, Heimes D. Potential risk factors for early and late dental implant failure: a retrospective clinical study on 9080 implants. Int J Implant Dent. 2020;6(1):81. https://doi.org/10.1186/s40729-020-00276-w.
24. Sakka S, Coulthard P. Implant failure: etiology and complications. Med Oral Patol Oral Cir Bucal. 2011;16(1):e42–4. https://doi.org/10.4317/medoral.16.e42.
25. Grigoras RI, Cosarca A, Ormenișan A. Early Implant Failure: A Meta-Analysis of 7 Years of Experience. J Clin Med. 2024;5(7):1887. https://doi.org/10.3390/jcm13071887.
26. Sorgato M, Bottin A, Stocchero M, et al. Impact of drill bit wear on temperature increase in dental implant osteotomy: an in vitro study. PLoS ONE. 2025;20(3):e0319492. https://doi.org/10.1371/journal.pone.0319492.
27. Jemt T, Olsson M, Renouard F, Stenport V, Friberg B. Early Implant Failures Related to Individual Surgeons: An Analysis Covering 11,074 Operations Performed during 28 Years. Clin Implant Dent Relat Res. 2016;18(5):861–72. https://doi.org/10.1111/cid.12379.
28. Krisam J, Ott L, Schmitz S, et al. Factors affecting the early failure of implants placed in a dental practice with a specialization in implantology – a retrospective study. BMC Oral Health. 2019;19:208. https://doi.org/10.1186/s12903-019-0900-8.
29. Chang LC. Risk factors associated with early failure of maxillary versus mandibular implants: A retrospective study. Int J Oral Implantol (Berl). 2020;13(1):55–63. PMID: 32186287.
30. Nyland AN, Lie SA, Gjerde CG. Risk Factors for Early Dental Implant Failure. Int J Oral Maxillofac Implants. 2024;39(1):164–72. https://doi.org/10.11607/jomi.10418.

31. Fouda AAH. The impact of the alveolar bone sites on early implant failure: a systematic review with meta-analysis. J Korean Assoc Oral Maxillofac Surg. 2020;46(3):162–73. https://doi.org/10.5125/jkaoms.2020.46.3.162.
32. Rodrigo D, Aracil L, Martin C, Sanz M. Diagnosis of implant stability and its impact on implant survival: a prospective case series study. Clin Oral Implants Res. 2010;21(3):255–261. https://doi.org/10.1111/j.1600-0501.2009.01820.x. PMID: 19958375.
33. Stocchero M, Jinno Y, Toia M, et al. Effect of Drilling Preparation on Immediately Loaded Implants: An In Vivo Study in Sheep. Int J Oral Maxillofac Implants. 2023;38(3):607–18. https://doi.org/10.11607/jomi.9949.
34. Lozano-Carrascal N, Salomó-Coll O, Gilabert-Cerdà M, Farré-Pagés N, Gargallo-Albiol J, Hernández-Alfaro F. Effect of implant macro-design on primary stability: A prospective clinical study. Med Oral Patol Oral Cir Bucal. 2016;21(2):e214–21. https://doi.org/10.4317/medoral.21024.
35. Al-Tarawneh SK, Thalji G, Cooper LF. Macrogeometric Differentiation of Dental Implant Primary Stability: An In Vitro Study. Int J Oral Maxillofac Implants. 2022;37(6):1110–8. https://doi.org/10.11607/jomi.9656.
36. Gehrke SA, Cortellari GC, de Oliveira Fernandes GV, Scarano A, Martins RG, Cançado RM, Mesquita AMM. Randomized Clinical Trial Comparing Insertion Torque and Implant Stability of Two Different Implant Macrogeometries in the Initial Periods of Osseointegration. Med (Kaunas). 2023;59(1):168. https://doi.org/10.3390/medicina59010168.
37. Norton M. Primary stability versus viable constraint–a need to redefine. Int J Oral Maxillofac Implants. 2013;28(1):19–21. PMID: 23377044.
38. Abrahamsson I, Carcuac O, Berglundh T. Influence of implant geometry and osteotomy design on early bone healing: A pre-clinical in vivo study. Clin Oral Implants Res. 2021;32(10):1190–99. https://doi.org/10.1111/clr.13816.
39. Sagnori RS, da Fonseca VJ, Lima LHF, Goulart DR, Asprino L, de Moraes M, Sverzut AT. Early dental implant failure associated with postoperative infection: A retrospective 21-year study. Oral Surg. 2024;17(3):214–20. https://doi.org/10.1111/ors.12875.
40. Chrcanovic BR, Albrektsson T, Wennerberg A. Reasons for failures of oral implants. J Oral Rehabil. 2014;41(6):443–76. https://doi.org/10.1111/joor.12157.
41. Jain S, Hemavardhini A, Ranjan M, Pasricha N, Thakar SS, Soni KJ, Hassan S, Goyal K, Singh D. Evaluation of Survival Rates of Dental Implants and the Risk Factors: A Retrospective Follow-Up Study. Cureus. 2024;16(3):e55360. https://doi.org/10.7759/cureus.55360.
42. Olate S, Lyrio MCN, de Moraes M, Mazzonetto R, Moreira RWF. Influence of diameter and length of implant on early dental implant failure. J Oral Maxillofac Surg. 2010;68(2):414–9. https://doi.org/10.1016/j.joms.2009.10.002.
43. Katafuchi M, Weinstein BF, Leroux BG, Chen YW, Daubert DM. Restoration contour is a risk indicator for peri-implantitis: a cross-sectional radiographic analysis. J Clin Periodontol. 2018;45(2):225–32.
44. Soulami S, Slot DE, van der Weijden F. Implant-abutment emergence angle and profile in relation to peri-implantitis: a systematic review. Clin Exp Dent Res. 2022;8(4):795–806.
45. Atieh MA, Shah M, Ameen M, Tawse-Smith A, Alsabeeha NHM. Influence of implant restorative emergence angle and contour on peri-implant marginal bone loss: a systematic review and meta-analysis. Clin Implant Dent Relat Res. 2023;25(5):840–52.
46. Tran DT, Gay IC, Diaz-Rodriguez J, Parthasarathy K, Weltman R, Friedman L. Survival of Dental Implants Placed in Grafted and Nongrafted Bone: A Retrospective Study in a University Setting. Int J Oral Maxillofac Implants. 2016;31(2):310–7. https://doi.org/10.11607/jomi.4681.
47. Yao J, Tang H, Gao XL, et al. Patients' expectations from dental implants: a systematic review of the literature. Health Qual Life Outcomes. 2014;12:153. https://doi.org/10.1186/s12955-014-0153-9.
48. Agarwal B, Srivastava S, Shekhar A, Arora K. Patient Satisfaction in Relation to Esthetic Outcome of Dental Treatment: A Systematic Review and Pooled Analysis. J Interdiscip Dent. 2023;13(3):117–27. https://doi.org/10.4103/jid.jid_34_23.
49. Papaspyridakos P, Bordin TB, Kim YJ, et al. Technical Complications and Prosthesis Survival Rates with Implant-Supported Fixed Complete Dental Prostheses: A Retrospective Study with 1- to 12-Year Follow-Up. J Prosthodont. 2020;29(1):3–11. https://doi.org/10.1111/jopr.13119.
50. French D, Ofec R, Levin L. Long term clinical performance of 10 871 dental implants with up to 22 years of follow-up: A cohort study in 4247 patients. Clin Implant Dent Relat Res. 2021;23(3):289–97. https://doi.org/10.1111/cid.12994.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Authors and Affiliations

G. Esteve-Pardo[1,2] · J. Amigó-Bardají[2,3] · L. Esteve-Colomina[1,2]

✉ G. Esteve-Pardo
gesteve@umh.es

1 Private Practice at Clínica Dental Esteve SL, Avd/ Alfonso X El Sabio 27, Etlo. F, Alicante 03001, Spain

2 Group Aula Dental Avanzada, Alicante, Spain

3 Private Practice at Clínica Dental Amigó, Valencia, Spain